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MILITARY SURGERY

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# CONTENTS

## SYMPOSIUM ON MILITARY SURGERY

	P
F w d	1523
By M J R C K L J C M S g C I U t i	
St t A m	
New S glcal M th d f Milt y S g lican	1525
By Li ut C I S KAV MRC U S A my	
O g i t n f th N y Medical D p tm nt	1533
By C R t L s H R MC U S N y	
An tl i i N I P etl	1545
B Li t C J R Ftl o MC U S N	
Ophtl lmi S g y ln th Army	1559
By L ut C I c H T r MC U S A my	
E N d Th t S g ry	1569
By L E t C D Fr MC U S A my	
Pl tl nd M H f lal S g y	1583
By C R t H l MRC U S A my	
Su g y f th Ch t	1593
By C R t F r L C i MC U S N y	
Su gle l Em g n l f th Abd m	1605
By C G tve A L r MC U S A my	
Tr tm nt f Cranl f l j i In W a	16 3
By D Fr c C G	
Milt ry U l glcal S g y	1637
By C A H C o MC U S N y d L t	
C C K A B oo MC U S N I Res r	
Sl k It P tl nd T tm nt	1663
By D s A Bk ock	
Milt ry O tl pedics	1685
By C N T I MC U S A	
M n g m t f F tu e in the Unit d Stat N vy	1 03
By C r t R c H l MC U S N y C	
W L D s MC U S N y d Lt ut Com	
C t F H L MC U S N	
M g m t f W d	1723
By C R t F r R Hoo MC U S N y	

# CONTENTS

P	ti	d T	tm	t f	Inf	t	In T	m ti	W	d	P
	B <sub>3</sub>	D	J	S	Loc	oo					1739
Imp	i ed	D es	ng	nd	Fq	ipm	t	Tra	p	t t	f th
	I j	ed									1751
	B <sub>3</sub>	C		C	RL	L A		MC	U S	N	
I tra		Fl	d	Th	rapy	i	Sh	k			1769
	B <sub>3</sub>	M	J	N		E F	M	MRC	U S	Arm	
X R	3	I	M	i t	ry	S	rg	ry			1783
	B <sub>3</sub>	C		C		F B		MC	U S	N	
A i t		Medi	t								1 93
	B	C		J		C A		MC	U S	N	
Mill	ry	D nt	1	S	rg	ry					1803
	B <sub>3</sub>	L		T C		R A S		T DC	U S	A	3
I d	t	N	i	m	19	20	d 21	(1939	1940	d 1941)	1809

# THE SURGICAL CLINICS OF NORTH AMERICA

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Volume 21

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## SYMPOSIUM ON MILITARY SURGERY

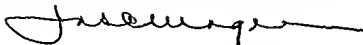
### FOREWORD

WITH the activities of the military establishment increased as the result of the present training program adequate medical care of our Army and Navy personnel becomes a problem of major importance. The Army and Navy medical establishments are expanding rapidly to meet the situation.

Inasmuch as time for special training in the medical and surgical specialties is not available the newly commissioned medical officer must depend upon his background of experience in civil life supplemented whenever practicable by brief orientation courses to assist him in applying that knowledge to the problems encountered in military service.

I consider the articles contained in this issue of the Surgical Clinics of North America as most opportune. Written by outstanding authorities cognizant of the necessary adaptations of civil methods to military practice they will provide a valuable fund of professional information for surgeons entering or thinking of entering the Services. They will likewise assist teaching institutions which in last analysis must give the fundamental training necessary for the practice of military medicine.

From the viewpoint of the medical services of the Army and Navy it is gratifying to note the close cooperation between military and civilian physicians in the preparation of this volume.



*J. S. G. of United States Army  
The Surgeon General*



# CONTENTS

P	ti	d T	im	ε f I f t	in T	m ti W	d	P
	B <sub>y</sub> D	J	S	Loc	oo			1739
Imp	ed D	g	d	Fq	ipm at	Tran p	t t n f th	17 t
	I J	ed						
	B C	C		L A		M C	U S A	
I tra		Fl id Th	py	ln Shock				1 69
	B <sub>y</sub> M J	N		E F	M	M R C	U S A m	
N R	y i	Milit	ry S	rg ry				1783
	B C	C		F B		M C	U S A	
A i		Med i						1 93
	B C	rr	J	C A		M C	U S A	
Milit ry	D	t i S	g ry					1803
	B <sub>y</sub> I	τ C	R	A S		D C	U A	
I d		A i m	19 20	d 21 (1939 1940		d 1941)		1909

## NEW SURGICAL METHODS OF MILITARY SIGNIFICANCE

I S RAVIDIN M D F A C S

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 D A M T S RESEARCH SCH M C I N U I V E R S I T Y  
 P L A I A

CERTAIN developments in the field of preoperative and post operative care will without doubt be of great value to our armed forces should they become involved in military actions resulting in casualties. In addition to these developments are some of a technical nature a clearer understanding of which will also lead to a substantial reduction in the morbidity and mortality of many injuries and a shorter period of convalescence.

Many of these extensions of our knowledge will be comprehensively dealt with in the papers by various authors which are to follow. It is my function merely to pass in review a number of these developments and to point out briefly their importance at this critical time. It is just as or even more important that the men entrusted with the surgical care of our soldiers and sailors be familiar with the significance of these new methods as it is that civilian surgeons be familiar with them. The successful military surgeon of the future will need to have the training and background of the civilian surgeon and in addition must obtain special knowledge of the problems of military action and movement. The mobile warfare of the present conflict has created and will continue to create new problems for the Medical Corp of the Army and Navy. Semi fixed hospitals can no longer be kept directly behind a front line for as yet little trench warfare has been seen



thetics during gunfire would preclude the use of certain of our more commonly used anesthetics. Furthermore the apparatus necessary for the administration of many anesthetics now commonly used in civilian hospitals may prevent their use at sea or on land except at more or less fixed stations. Will it not be comforting to know that the danger of chloroform injury to the liver can be greatly reduced by the provision of a sufficient amount of an adequate protein in the rations of our men? The protein need not necessarily be given as meat but can be given as some form of casein, soybean or protein digest.

An adequate protein intake is of importance not only in protecting certain viscera from the degeneration or necrosis which may follow exposure to a variety of harmful agents (chloroform, carbon tetrachloride, arsenic and the sulfonamides) but is of great importance also in facilitating *repair of injured tissues*. Tissue repair requires protein components and yet the soft diets given many patients during periods of convalescence are totally inadequate for maximal or even normal repair. One of my associates, Dr J. E. Rhoads, has recently demonstrated the importance of preventing hypoproteinemia if normal bone repair is to take place. The rapidity with which extensive wounds and decubitus ulcers undergo improvement when the protein intake is adequate is sufficient evidence to warrant a wider knowledge of this factor in the care of the convalescing surgical patient.

**Vitamins**—Not only is protein of value in maximal wound repair but an adequate intake of vitamin C also is required. A small amount of this vitamin in the body will result in the faulty laying down of collagen. Lanman and Ingalls and Lund and Crandon have opened a new chapter in surgical management by their excellent studies. Other vitamins also are of importance such as various components of the B complex, K, A and D.

**Fluids**—Normally the plasma protein of the blood is the major factor in keeping fluid in the blood vessels. A prolonged reduction of protein in the diet leads to hypoproteinemia which in turn predisposes to edema. Such a circumstance leads

in the present conflict. With the modern use of bombing planes ships are being exposed to a type of prolonged attack that was not possible when the battle was limited to fighting between ship. These and many other factors present new problems which must be met by changes in our methods of organization.

#### NUTRITIONAL FACTORS IN THE CARE OF THE INJURED

It has been known for a long time that the caloric requirements of men actively engaged in military action exceed those of men leading more sedentary lives. It has not been known, however, how important diet may be in the care of the injured. During the first Great War and for some years thereafter surgeons paid little attention to the diet of their patients. Many of the chronic disabilities which resulted after injury were due to our lack of knowledge both of the importance of nutrition prior to injury and its additional importance during convalescence. Surgeons were not alone in their ignorance of dietary requirements for medical men generally knew little about this important branch of science. The vitamins as we know them today were unknown, the intermediary metabolism of many of our food stuffs was not yet discovered.

Surgeons now know that the loss of weight of a patient during hospitalization is a concrete expression of the extent to which they have failed to meet the energy requirements of the patient during treatment. It became known during the war of 1914-1918 that patients with thoracic empyema improved more rapidly if they were kept on an intake of 4000 calories or even more. Dubois demonstrated that patients with extensive suppuration could not be kept in a positive nitrogen balance even though the intake of protein was several times that normally required to keep them in positive balance. But such data did not go far enough nor was the information of its importance sufficiently stressed to be of really significant value in the care of our patients.

**Adequate Proteins**—It may become necessary to use chloroform as the major anesthetic aboard our ships at sea for the risk involved in using inflammable or explosive anes-

thetics during gunfire would preclude the use of certain of our more commonly used anesthetics. Furthermore the apparatus necessary for the administration of many anesthetics now commonly used in civilian hospitals may prevent their use at sea or on land except at more or less fixed stations. Will it not be comforting to know that the danger of chloroform injury to the liver can be greatly reduced by the provision of a sufficient amount of an adequate protein in the rations of our men? The protein need not necessarily be given as meat but can be given as some form of casein, soybean or protein digest.

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**Fluids**—Normally the plasma protein of the blood is the major factor in keeping fluids in the blood vessels. A prolonged reduction of protein in the diet leads to hypoproteinemia which in turn predisposes to edema. Such a circumstance leads

not only to faulty wound healing but to an increase in the incidence of postoperative pulmonary complications wound infections and decubitus ulcers. Eventually it may be demonstrated that reduction of protein in the diet plays an important part in conditioning the onset of the syndrome of shock following trauma of a degree which under normal conditions of the plasma protein would not be sufficient to initiate shock.

The extensive development of *blood* and *plasma* or *serum banks* and the gradual adoption of the use of lyophile plasma has had a profound effect on surgical care. It is now almost as easy to administer plasma or serum as it is to administer sodium chloride intravenously. The advantage of these substances is that they will remain in the circulation while sodium chloride tends to leave the vessels rapidly. Even when considerable hemorrhage has occurred plasma will often be just as useful as blood and plasma has the additional advantage that agglutination tests are not required prior to its introduction.

### SHOCK

Dr Blalock, who in this Symposium is continuing the clinic on shock, has made many of the outstanding contributions to our knowledge on this subject. He would I am sure be one of the first to admit that much remains to be known about it. Blalock was the first to demonstrate the extensive local loss of fluid following serious trauma and he has repeatedly emphasized the fact that the replacement of this fluid by substances which are likely to remain in the blood vessel is the most important single factor in the treatment of shock.

The fall in blood pressure which many surgeons now look for as an indication of shock frequently takes place some hours after the initiation of the process which leads to the shocklike state. It would be of untold benefit were we able to diagnose the earliest signs of the progressive disturbances which lead to an irreversible state of shock. Heavy responsibility rests on those now carrying on investigations in this field. Until they have provided the necessary information we must continue to attempt to maintain a normal blood volume.

by the use of serum or plasma. It is far better to give too much serum or plasma than too little.

### BURNS

Because of the extensive burns which may result during and following air raids it is important that all useful knowledge on burns be made available. It is generally agreed that a serious reduction in blood volume follows extensive burning of cutaneous surfaces. The *blood volume* must be supported by serum or plasma transfusions for the process here is not unlike that seen in shock resulting from other forms of trauma.

Denuded cutaneous surfaces are highly susceptible to infection. Much of the infection which has been observed in burns has come about as the result of improper care. It is even more important to dress wounds due to burns with rigid regard to *asepsis* than to observe these principles in dressing ordinary postoperative wounds. Yet the care of wounds due to burns is often relegated to inexperienced individuals. Fortunately, it is now possible to limit greatly the extent, incidence and degree of infection by adequate wound treatment and the local use of sulfanilamide. If death due to a reduction in blood volume can be prevented, if infection can be aborted, then skin grafting can be carried out a short time after injury and what in the past has led too frequently to a protracted convalescence and extensive disfigurement in the future may lead to speedy recovery and a satisfactory cosmetic and functional result. In a clinic in this Symposium Dr. Ivy will illustrate the many ways in which the plastic surgeon can be of great help in the management of these cases.

### ANTISEPTIC AGENTS

During the war of 1914-1918 we were initiated to a host of new antiseptic agents, most of which except *Dakin's solution* have now been long forgotten. *Dakin's solution* remains as a useful agent because of its unique ability to cause lysis of necrotic tissue. The aim of surgeons in the present conflict must be to prevent invasive infection in contaminated wounds. The recent development of *sulfonamide therapy* leads us to believe that



the intelligent use of sulfanilamide, sulfathiazole or sulfadiazine orally, locally or parenterally will result in a substantial reduction in the number of serious infection which in past wars have been so common and have cost so many lives. Dr Lockwood and Dr Gibbon will discuss the management of many specific lesions.

### COMPOUND FRACTURE

When Orr first suggested the *closed plaster method* of treating compound fractures, the method was not widely adopted but when Trueta in Spain utilized the procedure during the Loyalist Nationalist war in that country, it was widely heralded and has now been extensively employed abroad and in this country. The method undoubtedly leads to a marked reduction in the incidence of secondary infection, to greater comfort to the patient because it does away with frequent dressings and without doubt in many instances to a higher incidence of bony union with less disability and a shorter convalescence.

The data of the war of 1914-1918 revealed that there was a progressive increase in the number of wounds containing hemolytic streptococci from the time the men were first treated in a casualty clearing station until they were admitted to a base hospital. Stokes and his colleague found that 15 per cent of the wounds were already infected with the hemolytic streptococci at casualty clearing station and Fleming and Porteus reported that 90 per cent of the wounds were infected when examined at the base. Such additional infection is a large part due to the contamination which took place during repeated dressings applied under improper conditions. The suffering, disability and loss of life which took place as a result of this contamination can now in large part be prevented. Every medical officer should receive training in the indications for the use of the closed plaster method, the method of its application and the part which chemotherapy may play as an adjunct.

The improvements in surgery are but a few of the advances recently developed that are of military significance.

They serve to illustrate the direction of surgical thought and the importance of attention to the many details outside of surgical maneuvers which may influence the final results of injuries. It is to be hoped that these and other additions to our knowledge may lead to a very marked reduction in the morbidity and mortality of the injuries which may occur to civilians and to our military forces in the event of war.

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# ORGANIZATION OF THE NAVY MEDICAL DEPARTMENT

LOUIS H. RODDIS M.D. F.A.C.P.

CAPTAIN MEDICAL CORPS UNITED STATES NAVY  
 MEDICAL BRIGADIER GENERAL WASHINGTON D.C.

THE principal divisions of the Medical Department of the Navy are

Medical Corps  
 Dental Corps  
 Pharmacists  
 Nurse Corps  
 Hospital Corps

The first of these the *Medical Corps* is made up of physicians who are graduates of recognized medical schools. These men are selected after careful physical and professional examinations. For appointment to the Medical Corps of the regular Navy they must also be citizens of the United States and less than thirty-two years of age. The number of medical officers in the Navy as prescribed by law is  $6\frac{1}{2}$  per thousand of the total authorized strength of the Navy and Marine Corps; thus if the total strength of the Navy and Marine Corps were 100,000 650 medical officers would be required.

The *Dental Corps* is made up of dentists who must be under thirty-two years of age, graduates of recognized dental schools and who also must pass a rigid physical and professional examination. The proportion of dental officers is one for every 500 of the authorized strength of the Navy.

The *Pharmacists* are not as definitely allotted by law. At present there are about 200 for the whole Navy. In addition to the

The proportion of these to the total strength of the Navy is as follows:  
 Medical Corps 1 to 160  
 Dental Corps 1 to 500  
 Pharmacists 1 to 500  
 Nurse Corps 1 to 100  
 Hospital Corps 1 to 100



performed under authority of the Secretary of the Navy. The orders of these bureaus are considered as emanating from him and having the full force and effect of his authority.

**Duties and Responsibilities**—In order to give an idea of the work of the Bureau of Medicine and Surgery it would perhaps be best to quote directly from the U. S. Navy Regulations the duties and responsibilities attached to this Bureau.

#### SECTION I.—DUTIES OF THE BUREAU OF MEDICINE AND SURGERY

##### 457

1. The Bureau of Medicine and Surgery under the direction of the Secretary of the Navy is charged with and responsible for the maintenance of the health of the Navy for the care of the sick and injured for the custody and preservation of the records accounts and properties under its cognizance and pertaining to its duties and for the professional education and training of officers nurses and enlisted men of the Medical Department of the Navy.

2. It is charged with the upkeep and operation of all naval hospital medical supply depots medical laboratories the Naval Medical School and of all technical schools established for the education of a large number of members of the Medical Corps Dental Corps Nurse Corps and Hospital Corps and with their repairs except as excluded article 484.

##### 458

1. The Bureau of Medicine and Surgery shall provide for inspection of the sanitary condition of the Navy shall recommend with respect to all questions connected with hygiene and sanitation affecting the service and to the end shall have opportunity for necessary inspection it shall advise with other bureaus and offices and refer to the sanitary features of ships under construction and in commission regarding berthing ventilation and location of quarters for the care and treatment of the sick and injured of the provisions for the care of wounded in battle and in the case of shore stations with regard to health conditions depending on location the hygienic construction and care of public buildings especially barracks and other habitations such as camps. It shall also advise concerning matters pertaining to clothing and food to water supplies used for drinking cooking and bathing purposes and to drainage and disposal of wastes so

practice of pharmacy they carry on the detail of finance and property accounting

The *Nurse Corps* is made up of women nurses who must be graduates of recognized nursing schools and not more than twenty-eight years of age at entrance into the Navy. The proportion of nurses is three per thousand of the authorized strength of the Navy.

The *Hospital Corps* is made up of enlisted men and consists of 3½ per cent of the total authorized enlisted strength of the Navy and Marine Corps. The men of this corps do much of the nursing work, first aid and practical pharmaceutical work. For various reasons women cannot be employed at these tasks on combat ships or in the field.

The task of the Medical Department of the Navy is a very large one. It includes the physical selection of all personnel, the maintenance of health and the care of the sick and injured, as well as the removal by retirement of those who have become permanently disabled or are unfit for further active service. It must be remembered too that this work has to be carried out both afloat and ashore and in many parts of the world under varying climatic conditions and in widely diverse surroundings. Also the civil population of some of our island possessions beyond the seas, notably Samoa and Guam, is entirely dependent upon the Medical Department of the Navy for all medical care.

The administrative head of the Medical Department of the Navy is the *Surgeon General* who is the chief of the Bureau of Medicine and Surgery. He is appointed by the President for a period of four years.

#### THE BUREAU OF MEDICINE AND SURGERY

The Bureau of Medicine and Surgery is the central administrative organization of the Medical Department. It is one of five bureaus established in the Navy Department by the Act of Congress of August 31, 1847. This Act provided that the several bureaus should retain the charge of record and accounts pertaining to their respective duties, such duties to be

performed under authority of the Secretary of the Navy. The orders of these bureaus are considered as emanating from him and having the full force and effect of his authority.

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for as these affect the health of the Navy. It shall safeguard the personnel by the employment of the best method of hygiene and sanitation both afloat and ashore with a view to maintaining the highest possible percentage of the personnel ready for service at all times and shall direct for use all such devices or procedures as may be developed in the sciences of medicine and surgery with a view to tend to an increase in military efficiency.

2. It shall be the duty of the Bureau of Medicine and Surgery to provide for the physical examination of officers and nurses and enlisted men with a view to the selection or retention of those only whose physical condition is such as to maintain and improve the military efficiency of the service of admitted or retained personnel and it shall pass upon the competency of medical professionals and staff of all members of the Hospital Corps for enlistment, enlistment and promotion by means of examinations conducted under its supervision in such forms as it may prescribe.

3. The Bureau of Medicine and Surgery shall recommend to the Bureau of Naval Affairs the implementation of Medical Department personnel for hospital and hospital ships and shall recommend and make recommendations as to the assignment and duties of medical officers and enlisted personnel of hospital corpsmen. It shall be charged with the administration of the Naval Corps and shall have power to appoint and remove all personnel subject to the approval of the Secretary of the Navy.

4. It shall require of all commanding officers of the property to inspect and report in triplicate the custody, transfer and issue of all supplies of every kind used in the Medical Department for its own purposes and shall have charge of the control of personnel employed at naval hospitals, medical supply depots, medical laboratories, the Naval Medical School and all technical schools for the education of all members of the Medical Department personnel.

5. It shall prepare the design of hospital ships insofar as relates to the efficiency of the care of the sick and wounded and shall provide for the organization and conduct of the Medical Department of such vessels.

6. The administration of care and transportation of the sick shall be under the jurisdiction and control of the Bureau of Medicine and Surgery except as otherwise provided in a title.

1841

**Organization.**—To carry out the tasks laid down by the Regulations which have been quoted above requires a commission and thorough organization of both the Bureau and of the

entire Medical Department. The main features of this organization will now be briefly described. First the Bureau itself consists of the office of the Surgeon General and Assistant Chief of Bureau. Under these men as directing head are the following divisions:

Hospitals and Inspections	Finance
Planning	Preventive Medicine
Chief Clerk	Publications
Dental Corps	Aviation Medicine
Medical Corps	Physical Qualifications
Hospital Corps	and Records
Nurse Corps	

While the titles of these divisions are almost self explanatory as to their duties a few words may be added in regard to the tasks of some of them. For example the *Division of Personnel* is responsible for the admission of personnel to the service their transfer and movement from one station to another their examinations for promotion their leave and other similar matters. The *Division of Finance* has to do with the preparation of the budgets and the approval of requisitions required to purchase supplies and equipment for the Medical Department throughout the world. A division of great importance is that of *Physical Qualifications and Records*. Records are to be found here of personnel extending back to the War of 1812. Another division which is of great value is that of *Preventive Medicine*. It is said that in civilian life the specialty of the general practitioner is obstetrics. It may almost be said that the specialty of the Naval surgeon is preventive medicine.

In the Bureau of Medicine and Surgery there is another important office—that of the *Chief Clerk*. The Chief Clerk is a civilian who has charge of and is responsible for civilian personnel. He is the assistant to the Surgeon General in regard to the entire administrative machinery of the Bureau.

Another division of considerable interest is that of *Publications*. Various technical books and manuals such as the Handbook of the Hospital Corps and also the Reports of the Surgeon General of the Navy are prepared and published for the

ue of the Medical Department. In addition, the Navy publishes a medical journal devoted to naval and military medicine. This journal, known as the *United States Naval Medical Bulletin*, was founded in 1907. It was for a long time the only journal devoted to naval medicine published in the Americas.

Another important unit, though not directly a part of the Bureau, deals with important Bureau policies. This is the *Advisory Board*, organized for the purpose of assisting the Surgeon General particularly with the work of postgraduate instruction. It also is concerned with other matters, especially the preparation of scientific and professional books and periodicals needed by the Medical Department. This board selects officers for postgraduate instruction in civilian medical schools and for special work in the Naval Medical School.

## FACILITIES FOR THE TRAINING OF MEDICAL PERSONNEL

### NAVAL MEDICAL SCHOOL POSTGRADUATE INSTRUCTION

The Naval Medical School, Washington, D. C., is a school of postgraduate instruction that specializes in the subjects of naval medicine. It is the only school giving instruction in this specialty in the United States and is the largest and most important one in the Western Hemisphere. Furthermore, its library contains the largest collection of books, periodicals, pamphlets, pictures, and other data on nautical medicine to be found in the New World. The Naval Medical School forms a part, with the Naval Hospital and the Dental School, of a great medical group known as the Naval Medical Center, Washington, D. C. One other important function of the Naval Medical School should be noted. The school serves as a consulting center for the entire Naval Service. Medical officers in all parts of the world send pathological specimens here for diagnostic study and confirmation.

### SCHOOLS FOR HOSPITAL CORPSMEN

Other important instruction carried out under the Bureau of Medicine and Surgery includes the training of hospital corpsmen. There are two training schools regularly maintained

—one at Norfolk Virginia and the other at San Diego California In these schools instruction is given in first aid elementary pharmacy and chemistry elementary hygiene and sanitation nursing and similar subjects as well as military drill Special instruction also is given in various technical branches to train men as technicians in the fields of x ray laboratory pharmacy dental prosthesis and related fields

#### NAVAL HOSPITALS AND OTHER FACILITIES FOR TREATMENT AND EXAMINATION

The Navy maintains a number of large and important Naval hospitals within the continental limits of the United States and three more beyond the seas The latter are at Canacao Philippine Island Pearl Harbor Territory of Hawaii and Guam Naval hospitals like large general hospitals in civil life contain patients with a great variety of pathological conditions requiring every sort of treatment These hospitals are equipped with every facility to be found in the largest and finest civilian hospitals Some idea of the volume of work which passes through them may be obtained from the data of a recent calendar year when more than 30 000 surgical operations were performed while there also took place many minor procedures such as cystoscopies bronchoscopies and similar examinations

The largest single group of diseases cared for in our hospitals is the group of communicable diseases transmitted by oral and nasal discharges This group furnishes almost one third of all admissions to the sick list Wound and injuries attributable to the many hazards peculiar to naval and military life are another important cause of morbidity These injuries provide about 10 per cent of all original admissions to the sick list Many of them occur in the operation of submarines the handling of guns and ammunition aboard ship falls through hatches and from masts falls overboard and similar accidents

The Naval hospitals are organized with the usual clinical and professional services Each hospital has surgical medical eye ear nose and throat and urological services as well as facilities for roentgenology and physiotherapy and laboratory

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neuropsychiatric and dental work. To most of the hospital an out patient clinic is attached. In each hospital are important administrative groups. These are: a personnel and record office, a property and accounting office, a commissary, a disbursing office, a maintenance department. There also is a group in charge of morale and training activities in connection with the instruction of hospital corpsmen on duty at the hospitals. The administrative head of our hospital is the medical officer in command, whose chief assistant is the executive officer. An officer of the day who is the direct representative of the Commanding Officer is on duty at all times in our hospital.

#### HOSPITAL SHIPS

An interesting activity of the Medical Department is that of the hospital ships. These are in effect floating hospitals designed to accompany the Fleet and to furnish hospitalization in any part of the world where the Fleet may go. The ships have to be moderately large, commodious, comfortable and fairly fast. Their medical facilities include practically every service found in a hospital ashore.

#### MOBILE BASE HOSPITALS

Mobile base hospitals are hospitals which can be assembled and their personnel and material moved to distant points where they furnish hospitalization particularly to advanced bases and Marine expeditionary forces.

#### MEDICAL DEPARTMENT OF SHIPS AND SHORE STATIONS

The number of medical departments of ships and shore stations runs into hundred. Every ship and shore station except the smallest is equipped with a medical department which includes a pharmacy, a medical store room, a examination room, a ward and in most instances a small isolation unit. While the hospital supply definitive treatment, these medical departments of ships and shore stations everywhere supply the temporary medical service to the officers and men of the ships and stations. They handle all acute conditions, all immediate

emergencies and provide the preventive medical service necessary to maintain the health of the command. A medical officer heads all these activities. He is often like the country practitioner in a small town with many of the same professional problems and in addition those of a military organization.

#### DISPENSARIES AND NAVY YARDS

Dispensaries and navy yards have an important task in connection not only with the care of Naval personnel but also with the provision of emergency treatment for civil employees. The medical officers of dispensaries of the yards have also the problems of industrial medicine to deal with in their regular work.

#### RECRUITING STATIONS AND TRAINING STATIONS

Medical officers of course are necessary at recruiting stations to carry on physical examinations of recruits. The physical selection of personnel is one of the most important tasks of the Medical Department. It requires not only the professional knowledge necessary to make physical examinations but an intimate acquaintance with the requirements of the Naval Service in order to select properly the best men. In the training stations these newly recruited men are again studied and many of the unfit eliminated during their period of training.

#### DENTAL SERVICE

As has been mentioned the Dental Corps consists of dental officers in proportion of one to every 500 men of the Navy. The dental officers furnish complete dental care. Great attention is given by the Dental Corps to prophylaxis and the prevention of various dental diseases and the relationship of dental infections to general pathologic conditions.

#### MEDICAL SERVICE WITH THE MARINE CORPS

It generally is not realized that the medical service of the Marine Corps is supplied by the Medical Corps of the Navy. Yet this is the case and to provide this service an organization of medical troops similar in general character to that of Army

units but still retaining special Naval features is required. The organization of these units is too extensive a subject to go into in detail but it will suffice to say that the medical service of the Marine Corps is almost a separate specialty of naval medicine in itself.

#### NAVAL MEDICAL SUPPLY DEPOTS

The Navy has several large depots and storehouses from which medical, surgical and hospital supplies and equipment are purchased for use in the Navy. These depots are responsible not only for the purchase and accounting of supplies but also for the testing of materials obtained to make sure that they meet specifications. The depots are also responsible for the filling of requisitions and the shipments of these supplies to hundreds of medical department units throughout the Navy.

#### NAVAL RESERVE

The Naval Reserve is made up of officers and men who are civilians engaged in civil pursuits. The men are organized into Naval training units to receive short periods of training in duties pertaining to various branches of the Naval Service. In the case of the Reserve force of the Medical Department there are included physicians, dentists, pharmacists, nurses and trained technicians, subject to call in time of national emergency. Careful physical and professional selection has been exercised in the formation of the Reserve Force of the Medical Department and it often includes the outstanding professional people of a community. The medical men and dental officers are frequently organized into hospital units. The whole plan is intended to furnish rapid expansion and augmentation of the regular Medical Department in time of war or similar national emergencies.

#### CONCLUSION

It must not be forgotten that the Navy is a military organization and that its medical service is organized and designed for a military purpose. The Navy forms a floating defense about the nation and its possessions behind which the ordinary pursuits of the ordinary citizen can be carried on safely.

from the attacks of any aggressor. And too it must not be forgotten that the essential units of the Navy are not steel ships. It is the men who really make a Navy and the maintenance of the health and physical fitness of the officers and men is the primary purpose of the Navy's Medical Department. All parts of the medical department are organized with one objective that of maintaining the physical efficiency of the personnel so that the maximum military efforts of the Navy can always be available. As Lord Nelson once very aptly said:

The very greatest thing in the military service is health

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# ANESTHESIA IN NAVAL PRACTICE

J R FULTON MD FACS

L A C MED CA C UN ED S TES N VY USS R  
INF U ITE S ES F ET

ANESTHETIC procedures used in our Naval hospitals dispensaries and hospital ships do not differ greatly from those used in civilian hospitals and clinics. Our problems there differ in no essential from those in civil practice. We have adequate equipment and a trained personnel that has kept pace with the ever broadening field of anesthesia. However there are certain factors influencing our choice of anesthetic agents and methods that would tend to explain our preponderant use of local regional and spinal anesthesia. We must always be prepared for war. Present day naval action presupposes a high casualty rate and each combat ship must face the prospect of independent action. Casualties cannot always be promptly evacuated for the train of a fleet which includes the hospital ships might be at a distant point or may itself suffer casualties. Under these conditions the surgeon of each combat ship must be able to perform traumatic surgery under stress with anesthetic agents which do not require special apparatus or assistants.

Combined with regional and local anesthesia the use of *nitrous oxide and oxygen* is highly satisfactory for all general surgical work. It would be ideal to have compact portable gas machines at each battle dressing station with trained assistants to operate them. However the lack of trained personnel aboard combat ships makes this method of limited value.

*Ether* given by the open drop method may be employed where the hazards of fire are not serious. Because of the relatively wide margin of safety in ether anesthesia enlisted per-

Th p sse t ta d h th p t es f th  
t d t t be t ed ficial fleet g th f th  
N y Dep rtm t th N l Serv t l g





Lundy<sup>2</sup> has emphasized the fact that patients with a hemoglobin of less than 50 per cent are exceptionally poor risks. The objection to spinal anesthesia in this type of patient can be obviated in the naval service by transfusion prior to operation and if necessary by continuing the blood during the operative procedure. The blood of all officers and men of the Service has been grouped and this grouping is etched on their identification tags and is also recorded in their health records which accompany the individuals throughout their service careers. Suitable donors are available on a moment's notice. The debilitated and aged group particularly those with cardiovascular or coronary disease are poor spinal risks. Spinal anesthesia is also contraindicated for patients who have spinal injuries or disease of the spinal cord and for those who are extremely nervous.

**Agents—Procaine or Metycaine**—Generally our experience with spinal anesthesia has been limited to the use of procaine, metycaine and pontocaine. The dose of procaine or of metycaine for spinal anesthesia is as a rule never more than 1 m. for each pound of body weight. The total amount administered does not exceed 200 mg. in the case of procaine or 150 mg. when metycaine is used. It has been found by experience that for spinal anesthesia 10 to 20 per cent less of metycaine than of procaine is needed for the average upper abdominal operation. We prefer to use procaine in those procedures which may be completed in less than one hour and in which no more than 150 mg. of the drug is required to secure adequate anesthesia. It has been found that concentrations of 3.5 to 5 per cent procaine or metycaine in spinal fluid give a most satisfactory anesthesia. Concentration greater than 5 per cent have not improved the efficiency of anesthesia and we are under the impression that when solutions of greater concentration have been used there has been a marked increase in the amount of postoperative ileus. With the use of metycaine we have secured satisfactory anesthesia and relaxation in procedures lasting one and one-quarter hours to one and one-half hours.

sonnel can be trained fairly easily in its administration. The danger of fire and explosion renders combustible gases such as *ethylene* and *cyclopropane* unsuitable aboard combat ships.

*Regional anesthesia* supplemented by pentothal sodium given intravenously would appear to be ideal under combat conditions if personnel with sufficient training were available to give the latter drug.

These conditions make it evident that the Navy is in need of surgeon anesthetists who are well trained in the technic of administration of local regional spinal and intravenous anesthesia. At our Naval hospital we endeavor to train our medical officers in the use of these methods of anesthesia.

### SPINAL ANESTHESIA

Generally throughout the Navy spinal anesthesia is the anesthesia of choice for all operations below the diaphragm unless there are definite contraindications to its use. In 1939 there were 3075 operations performed on Naval personnel under spinal anesthesia.

**Advantages**—There are several definite reasons for the predominant use of this method. Our service patients are healthy robust young adults who tolerate spinal anesthesia extremely well and who seldom show any of the toxic manifestations of the drug. Because of the exigencies of the service operations must be performed aboard ships at sea and in dispensaries of isolated naval stations where there may be at the most two medical officers in attendance. It is necessary under these circumstances for the surgeon to assume the responsibility of the anesthesia as well as that of the operation. Most observers are agreed that no anesthesia so easily provides such widespread muscular relaxation, intestinal quiet and easy recovery as does spinal anesthesia. Patients operated under spinal anesthesia require very little postoperative nursing attention and this becomes a factor aboard ship where facilities may be quite limited.

**Contraindications**—Spinal anesthesia is contraindicated in patients in severe shock particularly because of blood loss.

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*Pontocaine* —When time-consuming operations are to be carried out we have found the use of pontocaine extremely satisfactory. Operations lasting up to two hours are completed satisfactorily under this drug. In the majority of cases in which pontocaine is used there has been less fall in blood pressure than is seen under procaine or metycaine. The dose of pontocaine for upper abdominal anesthesia is usually from 14 mg to 18 mg depending upon the age, size and physical condition of the patient and the duration of the anesthesia desired. We have used the method proposed by Sise of combining dextrose with the pontocaine solution to aid in controlling the level of anesthesia.

*Technic —Premedication* —The technic used for spinal anesthesia in the Navy is generally uniform. The patient receives premedication the evening prior to operation which usually consists of 1 $\frac{1}{2}$  grains of *pentobarbital sodium* or 1 grain of *phenobarbital* by mouth to insure a good night's rest. One hour before operation 1 $\frac{1}{2}$  grains of pentobarbital sodium are administered by mouth and  $\frac{1}{4}$  to  $\frac{1}{2}$  grain of *morphine sulfate* is given hypodermically. Some surgeon anesthetists prefer to give *scopolamine*  $\frac{1}{60}$  grain combined with the morphine in routine cases. If supplementary anesthesia with an inhalation agent or by the intravenous method is contemplated *atropine sulfate*  $\frac{1}{60}$  grain is substituted for the scopolamine.

*Ephedrine* —Ephedrine sulfate is injected intramuscularly in all cases except those with hypertension about ten minutes prior to the time the spinal anesthesia is administered. It is our definite impression that we have seen less fall in blood pressure when ephedrine is administered at an interval prior to spinal anesthesia than when it is given at the same time as the spinal injection. In the average case 25 to 50 mg of ephedrine is used, the former dosage being employed in those cases in which the blood pressure is moderately elevated and the latter in cases in which the blood pressure is normal or when larger doses of the anesthetic are used.

*Sites of Injection* —The lumbar interspaces are the usual sites of injection. For anesthesia for operation on the upper

abdomen the first and second lumbar interspaces are used for midabdominal operations the second and third lumbar interspaces are used for lower abdominal operations and operations about the perineum and the lower extremities the space between the third and fourth vertebrae is used The anesthetic solution is injected slowly and regularly at a rate of 0.5 cc per second Barbotage is not employed

**Complications**—Sise<sup>4</sup> in a recent article has emphasized the necessity for careful attention and supervision of the patient under spinal anesthesia Serious and sudden complications may occur and the anesthetist must ever be on the alert to detect their onset Facilities for the administration of oxygen should be available at all times and ephedrine and neosynephrin should be on hand and ready to stimulate the patient should it become necessary during the course of the anesthesia

**Fall in Blood Pressure**—The most frequent complication of spinal anesthesia is a fall in blood pressure Practically every case shows some slight fall in systolic pressure The fall in blood pressure itself is not always a true indication of the condition of the patient and it in itself may demand no treatment However pallor lessened pulse volume shallow respirations associated with a fairly sharp fall in blood pressure are indications of the need for immediate supportive treatment When these circumstances are present it has been found that 25 mg of ephedrine or 0.1 cc to 0.2 cc of neosynephrin given intravenously will result in a rapid rise of the blood pressure If respirations continue to be shallow or if there is a gradual increase in the amount of intercostal paralysis or if the slightest amount of cyanosis appears oxygen inhalation should be begun at once and continued until the condition of the patient improves Oxygen to control this depression in the respiration may be supplied either by simple inhalation or by exerting pressure on the breathing bag of the gas machine

**Nausea and Vomiting**—Nausea and vomiting is a complication that is seen particularly in upper abdominal operations It is annoying to the surgeon and uncomfortable to the patient This complication may be due to the anesthesia itself or to the

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abdomen the first and second lumbar interspaces are used for midabdominal operations the second and third lumbar interspaces are used for lower abdominal operations and operations about the perineum and the lower extremities the space between the third and fourth vertebrae is used. The anesthetic solution is injected slowly and regularly at a rate of 0.5 cc per second. Barbotage is not employed.

**Complications**—Sise<sup>4</sup> in a recent article has emphasized the necessity for careful attention and supervision of the patient under spinal anesthesia. Serious and sudden complications may occur and the anesthetist must ever be on the alert to detect their onset. Facilities for the administration of oxygen should be available at all times and ephedrine and neosynephrin should be on hand and ready to stimulate the patient should it become necessary during the course of the anesthesia.

**Fall in Blood Pressure**—The most frequent complication of spinal anesthesia is a fall in blood pressure. Practically every case shows some slight fall in systolic pressure. The fall in blood pressure itself is not always a true indication of the condition of the patient and it in itself may demand no treatment. However pallor, lessened pulse volume, shallow respirations associated with a fairly sharp fall in blood pressure are indications of the need for immediate supportive treatment. When these circumstances are present it has been found that 25 mg of ephedrine or 0.1 cc to 0.2 cc of neosynephrin given intravenously will result in a rapid rise of the blood pressure. If respirations continue to be shallow or if there is a gradual increase in the amount of intercostal paralysis or if the slightest amount of cyanosis appears oxygen inhalation should be begun at once and continued until the condition of the patient improves. Oxygen to control this depression in the respiration may be supplied either by simple inhalation or by exerting pressure on the breathing bag of the gas machine.

**Nausea and Vomiting**—Nausea and vomiting is a complication that is seen particularly in upper abdominal operations. It is annoying to the surgeon and uncomfortable to the patient. This complication may be due to the anesthesia itself or to the



surgical procedures that are taking place. Sellman has recently reported a series of cases under spinal anesthesia in which pantopon was used as a substitute for morphine in the preoperative medication. In this series the use of pantopon rather than morphine apparently had some effect in lessening the incidence of gastric disturbances seen under spinal anesthesia. The nausea and vomiting that occur can be completely controlled by light intravenous pentothal sodium anesthesia.

*Extremely Nervous Patients*—Occasionally in spite of apparently adequate preoperative medication the patient arrives at the operating room nervous and apprehensive or becomes extremely restless during the course of the operation. These extremely nervous patients may be put to sleep with intravenous pentothal sodium before leaving the ward or it may be used during the course of the operation as a supplementary anesthetic. Morphine sulfate  $\frac{1}{8}$  to  $\frac{1}{4}$  grain in 2 cc of distilled water may be slowly injected intravenously before or during any operation under spinal, regional or local anesthesia to control exceedingly nervous and apprehensive patients.

*Continuous Spinal Anesthesia*.—A discussion of spinal anesthesia would not be complete without mention of the continuous method of spinal anesthesia recently introduced by Lemmon. In this method the needle remains in situ during the operation and as the need arises the anesthetist injects additional amounts of the anesthetic solution through a tubing attached to the needle. A malleable German silver spinal needle, a section of small bore rubber tubing and an operating table cushion with a cut out section to provide space for the needle and tubing are the only special equipment necessary to employ the method.

At one of our Naval hospitals we have used this method in seventy six selected cases since July 1940. We have used it mainly in prolonged operations on the stomach or colon. There has been only one failure to produce adequate and satisfactory anesthesia and this was apparently due to faulty technique in placing the needle. In all our other cases there was no difficulty in maintaining the level and extent of anesthesia necessary and

the operations were all completed under spinal anesthesia. The longest operation was of three and one half hours duration. The total dosage in this case was 500 mg. of metycaine. We have used novocain (4 and 5 per cent solutions) and metycaine (3.5 and 4 per cent solutions). We have found that the anesthesia produced by metycaine definitely lasts longer and that the total dosage in the cases in which metycaine was used was less than in operations of the same duration in which novocain solutions were used. In our series about 3 cc. of the anesthetic solution was necessary to produce initial full abdominal anesthesia. Additional increments of 1 cc. to 1.5 cc. were injected when necessary to maintain the desirable level of anesthesia.

*Clinical Value of Continuous Method*—Because of the small dosage of the drug necessary to produce initial adequate anesthesia we have observed very slight if any fall in blood pressure and pulse and respiration have shown no material changes. By withdrawal of the spinal fluid it has been found possible to terminate the anesthesia at any time in a great majority of the cases in which this method is used. This would appear to be a very important factor if toxic symptoms should develop. The small fractional doses of the anesthetic solution necessary to maintain satisfactory anesthesia, the fact that anesthesia may be terminated by withdrawal of spinal fluid should toxic symptoms develop and the fact that prolonged anesthesia may be maintained without apparent danger to the patient would make this method one of obvious clinical value.

#### LOCAL AND REGIONAL ANESTHESIA

There were 1544 operations (exclusive of tonsillectomy, circumcision and other minor procedures) performed on Naval personnel under local anesthesia during 1939.<sup>1</sup>

*Agents*—*Procaine* is considered generally to be the most valuable of all local anesthetic agents because of its comparatively low toxicity and wide margin of safety. During the past two years we have used increasing amounts of *metycaine*. *Metycaine* as a local anesthetic has certain advantages. It is our impression that it produces anesthesia more quickly, more

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half of the skull is to be blocked a semi batband type of infiltration is used. The skin, superficial fascia and muscle are infiltrated with the anesthetic solution but it has not been found necessary to inject the periosteum. The bones of the skull may be sawed, drilled or cut without painful sensation. Wounds of the face are easily blocked by regional infiltration across the paths of the sensory nerves.

**Neck**—Paravertebral block of the second, third and fourth cervical nerves combined with superficial cervical field block will produce sufficient and satisfactory anesthesia for all operations commonly performed on the neck.<sup>6</sup> Cervical block in our experience has proved most satisfactory and is our method of choice for all surgical procedures on the thyroid gland.

**Chest**—Injuries of the chest including open pneumothorax may be treated by a combination of paravertebral intercostal block and subdermal infiltration. Nitrous oxide and oxygen administered under pressure from the gas machine as a supplement to the regional anesthesia would add greatly to the safety in these emergency intrathoracic operations.

**Abdomen**—For penetrating and major abdominal wounds when spinal anesthesia is contraindicated, satisfactory anesthesia may be accomplished by a combination of abdominal field block and intercostal nerve block. Abdominal field block combined with anterior splanchnic anesthesia by direct subperitoneal infiltration will give adequate surgical anesthesia and marked relaxation. With many of our surgeons, local anesthesia is the method of choice for such low abdominal operations as appendectomy and the repair of inguinal hernia. In any abdominal operation if the local anesthesia is not sufficient it may be supplemented by intravenous pentothal sodium with excellent results.

**Rectum and Anus**—In the Navy the great majority of operations on the rectum and anus are performed under regional or local anesthesia. Some of our surgeons prefer sacral block, others low spinal anesthesia. Infected pilonidal cyst is a common occurrence among Naval personnel. For the excision of low pilonidal cysts low spinal anesthesia is preferred because of the infected field

surely and has a longer duration of action. For this reason we believe metycaine is the agent of choice for cervical block, paravertebral block, block of the brachial plexus and sacral block. Clinically metycaine is no more toxic than procaine as a regional anesthetic.<sup>7</sup>

**Vasoconstrictors**—Vasoconstrictors such as *epinephrine*, *cobefrin* and *neosynephrin* are incorporated in local anesthetic solutions in order to produce a more lasting effect and improve hemostasis. These drugs are usually omitted in local anesthetic procedures on the fingers and toes, also in cases with coronary disease or hyperthyroidism. Procaine and metycaine solutions should be warmed to body temperature prior to injection. The use of a cold solution is apt to delay the onset of anesthesia.

**Preliminary Medication.**—Adequate preliminary medication is essential for successful local anesthesia. It is important that the patient arrive at the operating room without nervousness or fear. The more commonly used drugs are morphine, scopolamine and several barbituric acid derivatives. The chief effects of the barbiturates are to decrease nervousness and to protect against toxic reactions from the local anesthetic agents. *Pentobarbital sodium* in doses of 1 to 3 grain is given routinely one and one half hours before operation. In addition *morphine sulfate*  $\frac{1}{6}$  to  $\frac{1}{4}$  grain is administered hypodermically one hour before operation. *Atropine sulfate* is usually withheld unless there is the likelihood that supplementary intravenous or inhalation anesthesia may become necessary to complete the operation.

**Head**—Recent experiences in Europe have stressed the importance of local anesthesia in the treatment of war injuries. The surgeon-anesthetist trained in local and regional anesthesia will accept all lesions of the head, neck, body and extremities. Anesthesia sufficient for all scalp wound and craniotomy may be accomplished by the so-called "hatband" type of infiltration. This is performed by injecting the anesthetic solution from the glabella over the frontal bone above the eye and around the ear to the occiput. The procedure is then continued in a like manner on the other side of the head. If only

anesthesia which has proved comparatively safe satisfactory and essentially free from complications

**Advantages**—During the past two years an increasing number of Naval medical officers have become familiar with pentothal sodium and the technic of its administration Recent experiences in Europe have brought to our attention its importance in military surgery The introduction of pentothal sodium has given us a drug and a method of anesthesia for war time conditions which in our opinion will be of great value Pentothal sodium administered intravenously produces rapid induction of anesthesia with quick recovery it is fireproof and nonexplosive and does not require elaborate equipment to administer All these advantages would seem to make it a most valuable addition to our armamentarium in mobile hospitals battle dressing stations and in the sick bays of combatant ships where a great number of wounded must be taken care of by a limited medical personnel

**Technic**—We employ the intermittent technic of administration as originally advocated by Lundy using a 2½ per cent solution of the drug It is felt that the 2½ per cent solution has many advantages over the 5 per cent solution With the more dilute solution induction is slower it is felt that the anesthetist has better control of the patient probably less of the drug is used and the danger of phlebitis is minimized

**Oxygen**—It has been found that the continuous administration of oxygen or a mixture of oxygen and nitrous oxide during prolonged procedures under intravenous anesthesia permits more extensive operations than could ordinarily be performed Respirations are more vigorous and can be noted by watching the exchange in the bag of the gas machine When this technic is used more profound anesthesia and relaxation can be secured with apparently less danger of anoxia

**Premedication**—Preoperative medication and preparation of the patient are of the greatest importance The necessity of *atropine* cannot be too strongly stressed Not only does it reduce the secretions of the upper respiratory tract but it lessens the tendency to laryngeal spasm occasionally seen when intra

**Extremities**—Traumatic wound especially those involving severed tendons and nerves and amputations are excellent cases for the use of local anesthesia. Difficult identification of the tendons and nerves is made easier when the patient can cooperate in voluntary manipulation of the traumatized extremity. Fracture dislocations and traumatized wounds of the *upper extremity* may be successfully treated under brachial plexus block. Unfortunately there is a fairly high percentage of failure to secure adequate anesthesia with this particular type of block and we feel that a supplementary anesthesia should be available when it is being used. Naval personnel have a high incidence of traumatized wounds of the *hand*. Ulnar and median nerve block at the wrist combined with an annular infiltration at the same level gives excellent anesthesia for the emergency treatment of these wounds.

**Fractures and Dislocations**—We have found local anesthesia adaptable to all types of fracture and dislocations. One of our medical officers has reported the use of local anesthesia in the treatment of 200 consecutive cases of fracture and dislocation without resort to general anesthesia. The only requisite to the use of local anesthesia in these traumatic cases is the attainment of surgical cleanliness at the site of the injection of the sterile anesthetic solution. Adequate anesthesia can be obtained by the injection of the anesthetic solution into the bellies of the muscles involved in the mechanics of the injury combined with a transverse block of the regional sensory nerves about five centimeters above the fracture line. It is not necessary to enter the so-called fracture hematoma to secure adequate anesthesia and muscular relaxation.

#### INTRAVENOUS ANESTHESIA

The first recorded use of intravenous anesthesia in the Navy was in 1935 when five minor operations were performed under intravenous evipal anesthesia. *Pentothal sodium* was first used in the Navy in 1938. Since the introduction of pentothal sodium the intravenous method of anesthesia has gained rapidly in popularity and provided us with a method of general

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great extent in transurethral and cystoscopic operations and manipulations

*Fresh Burns etc*—Pentothal sodium is our anesthetic of choice in the treatment of fresh burns especially those contaminated by grease or fuel oil also in such minor procedures as the opening of abscesses removal of packing the dressing of large denuded surfaces and other painful procedures

**Contraindications**—Until quite recently most observers have agreed that pentothal sodium should not be administered to patients who have been receiving sulfonamides unless the latter drug had been withdrawn at least twenty four hours before operation Of definite interest and importance from a naval and military standpoint are recent reports from England<sup>4</sup> which would appear to indicate that pentothal may be used in combination with the sulfonamides with no ill effects Intravenous pentothal sodium anesthesia is contraindicated in cardiorespiratory diseases associated with dyspnea It should not be used in operations in which it would be difficult to maintain a free airway and in cases in which blood and mucus may act as a potential obstruction in the airway Except for the most brief and minor procedures pentothal sodium should not be given intravenously unless the facilities for administering oxygen and carbon dioxide are available

#### SUMMARY

Modern naval warfare presupposes heavy casualties Battle conditions aboard a combatant ship limit the choice of anesthetic agents and methods Fire hazards in the battle dressing stations render explosive and inflammable agents unsuitable aboard ship Small compact portable gas machines to supply nitrous oxide and oxygen should be available at all battle dressing stations Local regional spinal and intravenous anesthesia would appear to be the method which are most applicable under combat conditions World affairs are such that the need of surgeon anesthetists trained and experienced in the above methods is quite evident

venous barbiturates are used. Sufficient *pentobarbital sodium* to render the patient sleepy before he is brought to the operating room give a smoother anesthesia, minimizes apprehension and reduces the amount of *pentothal* required. For the average patient  $1\frac{1}{2}$  grains of *pentobarbital sodium* is given one and one half hours before operation. *Atropine sulfate* .150 grain is usually combined with *morphine sulfate*  $\frac{1}{6}$  grain subcutaneously one hour before operation. For short operative procedures all preliminary medication except the atropine is usually omitted. The patient should be brought to the operating room with an empty stomach, bladder and rectum.

**Indications for Use**—Although the trend in late literature is continually toward displacement of other anesthetic agents by *pentothal sodium* we have found this method of anesthesia most applicable for short and minor surgical procedures especially in cases in which the operation does not involve the respiratory passages or when extensive muscular relaxation particularly abdominal is not required.

**Supplemental to Other Methods of Anesthesia**—We have found the method of particular value as a supplement to spinal anesthesia when the effect of the latter begins to wear off before the operation has been completed or when annoying nausea and vomiting are present. Local and regional anesthesia supplemented by intravenous *pentothal sodium* has given us satisfactory anesthesia for extensive intra abdominal procedures.

**Fractures and Dislocations**—It is an ideal anesthesia for the reduction of simple fractures and dislocations especially if there is an associated head injury.

**Procedures about the Head**—The method is particularly well suited for operations about the eye and for the treatment of traumatic lesions of the face, scalp and neck. In operation about the head it removes the anesthetist and the equipment from the operative field and lessens the danger of contamination.

**Transurethral and Cystoscopic Procedures**—Intravenous anesthesia has displaced local spinal and sacral anesthesia to a

# OPHTHALMIC SURGERY IN THE ARMY

FREDERIC H THORNE M D F A C S

L UT C MED CA C U T R St ES A CH EF EYE,  
E N A T SER C S H F S t H U  
TEX S

THE Army offers a fertile field to the medical officer who desires to specialize in the practice of ophthalmology. Its possibilities are equal or even superior in many respects to the practice of this specialty in the free and semi free clinics and infirmaries throughout the country. The personal interest developed in each case the great variety of conditions encountered and the opportunity to follow each case to its ultimate conclusion insure one an ophthalmic practice of which any specialist would be proud. The personal interest is markedly developed because the Army is after all one large family regardless of the official status of the individual.

The physician who adopts ophthalmology as a specialty assumes a grave responsibility. Useful vision on the one hand or blindness on the other in many instances is dependent upon his judgment and experience and upon his ability to use his hands efficiently. The patient with the utmost confidence places his chances of regaining or retaining his vision entirely in the keeping of the physician. This confidence becomes apparent particularly in the practice of elective surgery.

## THE NEED FOR A SEPARATE BRANCH OF OPHTHALMIC SURGERY IN THE ARMY HOSPITAL

In most of our Army hospitals the eye ear nose and throat specialties constitute either a separate hospital service or they

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operate as sections of the general surgical service but always under one chief and in most instances the personnel is required to do both eye and ear nose and throat operations. From the standpoint of organization whether the two branches constitute a separate service or not makes little or no difference because to the best of my knowledge there is no handicap attached to either arrangement. What is decidedly important however is the separation of the personnel for eye surgery from that for surgery of the ear nose and throat. The two sections can function with perfect satisfaction under one head whether or not they operate as sections or as a service but the same surgeon cannot efficiently practice eye and ear nose and throat surgery in the Army at the same time.

The particular reasons behind this need for the two branches to be kept distinct are first that there are always more operations and clinic treatments in connection with disturbances of the ear nose and throat than there are with those of the eye. Furthermore the character of the work of the one is so different from that of the other that it is nearly an impossibility for a surgeon to be particularly efficient in both. Again the efficient eye surgeon or the ear nose and throat surgeon must possess a particular personality that will permit him to pursue efficiently his chosen work but this personality is not applicable to eye and to ear nose and throat surgery alike. Because of the amount of work incident to ear nose and throat the surgeon is unable to devote sufficient time to ophthalmology since the examinations treatments and surgical procedures are painstaking and require a large amount of time. Because the personnel in the Army clinics has been required to practice ophthalmology together with ear nose and throat surgery it has in most instances resulted in a large number of particularly well trained ear nose and throat specialists while a very small number of surgeons have been able to practice ophthalmology sufficiently to become truly proficient. Furthermore our clinics in most instances have been constructed to meet the need of the ear nose and throat section whereas the eye section has received little consideration. This condition however is not necessarily

a serious handicap because by means of a slight rearrangement and some ingenuity a decidedly satisfactory eye clinic can be established with slight expense and labor provided sufficient space is available in the clinic. Insofar as ophthalmic equipment is concerned an adequate and efficient supply is always available and when it is not placed in efficient use the fault usually lies with the personnel concerned.

The aim of the ophthalmic surgeon differs basically from that of the general surgeon in that the former strives to restore or preserve vision while the latter strives to preserve life. The life of the ophthalmic patient is less likely to be at stake and an injury that in another part of the body would be trifling may easily result in total blindness if not carefully and properly handled. The blind individual in many respects is the most helpless and dependent of all cripples with which our state or organizations are burdened.

Ophthalmic conditions amenable to surgery as the subject applies to our present Army may be divided into two groups and should we be drawn into war into three groups.

#### GROUP 1 OCULAR DEFECTS IN APPLICANTS FOR ENLISTMENT AND IN ENLISTED MEN

Here we may discuss the correction of ocular defects for the purpose of qualifying the otherwise sound individual for the military service or if he is enlisted already to retain him in the service. This duty is primarily the responsibility of the civil organizations or of the individual himself rather than that of the Medical Department of the Army.

According to the report of the Medical Department of The United States Army in The World War nearly 4 per cent of the population of military age was found to have serious ocular defects. The percentage of the defects that were potentially capable of correction is not available but considering the number that are to be found in the Army among men called for military service today it must have been high.

The following ocular defects potentially capable of correction are specifically disqualifying for the military service.



Pterygium encroaching upon the cornea	Chronic dacryocystitis
Disfiguring cicatrices	Ptosis
Symblepharon	Prominent or well marked strabismus
Ectropion	Diplopia
Entropion	

The above defects are disqualifying because of their effect upon efficiency through disfigurement and discomfort and psychic influence and the possibility that they might lead to an impairment of visual efficiency sufficiently severe to make useful service of the individual impossible. These defects are potentially capable of correction and in most instances can be corrected by the experienced ophthalmic surgeon. It is true that such visual defects as the suppression amblyopia found in monocular strabismus with first degree fusion cannot be overcome to any great degree but the excellent cosmetic results that can be attained in these cases accompanied by some increase in usual efficiency exert a dramatic psychic effect upon the individual that increase his general efficiency a hundredfold. It has been noted in many instances that the correction of a manifest strabismus completely changed the personality of the individual exactly as it has been noted to do so frequently in the case of strabismus in a child. The cross-eyed soldier seemingly without a friend in the world has following a satisfactory correction blossomed into a smart and efficient soldier worthy of any organization.

The ideal situation insofar as the Army is concerned would be for the individual to have these defects corrected while in civilian life but in nearly all instances it is impossible for him to do so. Cases found in the Army certainly should be corrected by the Army ophthalmologists and in most instances they are and the individuals are returned to duty rather than given a discharge for physical disability. There remains the question whether or not all men with potentially correctable defects should be admitted into the service and the necessary corrections made after admission. This question is for higher authority to decide but should such men be taken into the service

without discrimination an important percentage of physically disqualified individuals would be made available for and able to render efficient service

## GROUP II OCULAR INJURIES AND DISEASES INCURRED IN SERVICE

Ocular defects incurred after entrance into the service may be of any type and severity but the larger percentage of them are traumatic in origin

Ocular injuries that occur when masses of individual are transported to new environments are necessarily higher than those that occur in civil life and the number of such injuries is again larger in the Army because of the close association of men with machines instruments of war and so forth with which they are unfamiliar Ocular injuries incurred in fistie altercations athletics and automobile and other accidents undoubtedly are about the same in number and severity as those from the same causes in civil life Added to these in the Army however are the ocular injuries incurred in military aviation The number of these injuries is large and they usually are of great severity

Aside from injuries that require surgical interference there are the retinal detachments inflammatory reactions involving the lacrimal sacs inflammatory reactions within the orbits and still other conditions that must receive attention The soldier is after all prey to all ocular conditions requiring surgery that are encountered in civil life including cataract and glaucoma

## GROUP III OCULAR BATTLE INJURIES

It is difficult to foretell the number of ocular injuries that may be incurred incident to battle The number of such injuries incurred in World War I would give one some idea of the number to expect but statistics of these injuries are not available at this time Owing to differences in the methods of conducting the present war as compared with those employed in the war of 1914-1918 the figures of the former would be of questionable value in any case However should we be drawn

into the present war the ocular injuries will be many and of every character and every degree of severity that can be imagined. Many of these injuries will be so destructive that vision cannot be preserved regardless of the efficiency of the treatment administered. Many others will be fatal to vision unless prompt and efficient treatment is administered by an experienced ophthalmic surgeon. In still other instances of course men with eye injuries will retain their vision regardless of the type of treatment received. Not only will the acute surgical cases present an enormous amount of work but ophthalmic reparative surgery will demand the services of the ophthalmic surgeons to an extent as great if not greater than will the acute phase of treatment.

**Gas Injuries**—Apart from gunshot wounds of all descriptions that will be incurred there is always the possibility of poisonous and irritating gases being employed. To what extent irritating gases will destroy vision is not definitely known since much of their effect depends upon the concentration of the gas and the length of exposure to it as well as upon the character of the gas itself. It was noted during World War I that mustard gas seriously affected the eyes of many soldiers.

In the past few years the writer has treated one patient whose eyes were injured by smoke and one with tear gas injury, and the severity of the injury in each was dependent upon the concentration rather than upon the character of the irritant themselves. The first case was that of a soldier working at a table on which a smoke bomb had been placed. The bomb rolled from the table onto the floor where it exploded at the soldier's feet. He received a considerable blast of smoke in his face. The resultant injury to his right eye consisted of marked conjunctivitis and keratitis with ulceration and late complete symblepharon of the lower lid and entropion. After a long period of treatment the cornea healed, the symblepharon was corrected with grafts and vision was restored to 20/40 with correction.

The second case to come under observation and treatment was that of an officer who stooped to pick up a tear gas bomb

from the ground. The bomb exploded in his hand and a quantity of the contents struck him in the face. He was able to walk to his car and drive himself to the infirmary where he was given first aid treatment and placed in bed. Ten days later he was transferred to a general hospital. At the time of his admission to the general hospital his eyelids were closed but he could distinguish between light and dark with either eye. The lid could be separated slightly revealing a narrow band of clear cornea at the inferior limbus. Otherwise the lids were firmly adherent to the globes. The upper lid of the left eye was dissected free from the globe up to the fornix and the inner surface covered with a mucous membrane graft secured from the cheek. During the dissection the cornea was found to be densely opaque and iris pigment was scattered throughout the adhesions covering the cornea. Apparently the cornea was perforated at the time of the injury. Whether the globes can be saved and whether eventually keratoplastic operations can be performed remain to be seen.

In both these cases insofar as could be determined the injuries were due directly to the gas and not to fragments of bomb casing or other debris. These cases indicate clearly that severe ocular injuries may be and likely will be incurred from irritating gases should such gases be employed.

#### EXTENT OF OPHTHALMIC PROBLEMS IN OUR PRESENT DAY ARMY

The following statistics may serve as a basis for estimating the number of ophthalmic treatments and operations which are likely to be required in the present day Army. In one concentration area with an average military population of 23,500 between January 1 and June 1, 1941, 4918 patients passed through the eye clinic, 113 of them being admitted to the hospital ward. Forty-nine ophthalmic operations were performed for the correction of defects which existed prior to entrance into the service and ninety-three for correction of defects and injuries incurred after entrance into the service. All these surgical corrections were considered necessary to permit full mili-

tary duty or to preserve or improve vision or in the case of enucleations for acute panophthalmitis and related conditions they were imperative.

The operations for the correction of defects existing prior to entrance into the service covered a wide range of conditions including strabismus pterygia chronic dacryocystitis and ectropion with strabismus and pterygia heading the list by wide margins. The operations performed for conditions incurred after entrance into the service included extraction of intra ocular foreign bodies enucleations following injuries laceration of cornea and sclera traumatic and senile cataract extractions repair of detached retina and correction of depressed floor of orbit.

With few exception correctable ocular defects whether traumatic or otherwise occur in about the same proportions in all parts of the United States. When the statistics presented above are applied to the entire Army whose strength is about 1 386 000 at this time it will be seen that in every six months there will be about 2 901 62 ocular treatments or 5 803 21 each year so long as the Army remains at its present strength. In every six months there will be 6667 admissions to hospital wards or 13 334 each year for the treatment of ocular conditions. There will be about 2891 operations performed every six months or 5782 each year for the correction of ocular defects which existed prior to entrance into the service. There will be about 5486 operations performed every six months or 10 974 each year for the correction of ocular defects which were incurred after entrance into the service.

The number of refractions performed during the six months period in the concentration area just mentioned was 676. By the application of this ratio to the whole Army there will be 39 884 refractions performed every six months or 79 868 each year.

#### RECOMMENDATIONS

As the Army increases in size all the number of ophthalmic operations increase in proportion. Should we be drawn into war the Army is likely to increase many times its present

strength. The injuries to be incurred in battle will be nearly unlimited in number and will have to be treated in addition to the load already carried by the Army.

**Ophthalmic Centers**—Because of the number of ophthalmic surgeons entering the Army at this time the care of ophthalmic cases is provided for fairly well at least in most areas but it cannot be assumed that the present provisions will be adequate to cope with conditions presented by a greater increase in the Army and by engagement in active hostilities. It is believed that a plan similar but on a larger scale to that used during the war of 1914-1918 if put into effect at once would be satisfactory. Under this plan certain large Army hospitals that are distributed fairly evenly throughout the United States would be designated as ophthalmic centers and all ophthalmic cases sufficiently severe to warrant hospitalization for more than a brief period would be transferred immediately to the nearest of these hospitals.

These ophthalmic centers would each require an adequate number of thoroughly trained ophthalmic surgeons whose duties would be confined solely to the demand of ophthalmology and to ophthalmic plastic surgery. Each center would have to be completely equipped so that all types of ophthalmic procedures could be adequately conducted. In addition to the ophthalmologists on duty in these centers there would have to be a sufficient number of technicians trained in perimetry, optics, orthoptics and related branches. Two such technicians in each center would be adequate. Nurses are not trained in this type of work and therefore would not meet the requirements.

With an ophthalmic personnel as outlined and with adequate equipment and space the military personnel transferred to such centers for treatment would be assured of receiving the benefit of the best ophthalmic care that can be secured in the United States. Furthermore all station hospitals should have on duty a trained ophthalmologist to examine eye cases to determine whether or not the condition warrants the transfer of the patient to the ophthalmic centers. Only the trained ophthalmolo-

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## EAR NOSE AND THROAT SURGERY

DANIEL FRANKLIN M D F A C S

LIEUTENANT COLONEL DANIEL FRANKLIN, M D, F A C S, U S ARMY, WASHINGTON, D C

Surgery of the ear nose and throat will be discussed under two headings namely (1) Routine Surgery and (2) War Surgery

### I ROUTINE SURGERY

Army Regulations specify certain conditions as causes for rejection for military service Some of the more important are (1) acute or chronic suppurative otitis media (2) perforations of the membrana tympani (3) malformations deformities and ulcerations of the nose (4) septal deviations causing obstruction (5) acute or chronic inflammations of the nasal accessory sinuses or hay fever and (6) chronic laryngitis from any cause

**Comparison with Civilian Practice**—The above causes for rejection are enumerated to show that in the Regular Army which is made up of a highly selected group of men only a very limited amount of surgery will be required for chronic disease and the correction of abnormalities as compared with the large amount of surgery needed for such conditions among civilians The surgery indicated for the usual acute conditions of the ear nose and throat differs in no respect from that of civilian practice

During the present emergency the standard of physical requirements for men under the Selective Service Act have been considerably lowered The hurried manner in which large



gist can determine with any degree of accuracy whether or not a given case is serious or potentially serious

**Organizational Problems**—Carrying these recommendations somewhat further it is believed that eye ear nose and throat and maxillofacial surgery should be combined into one service but should function as separate sections within the service. All efficient ophthalmic surgeons are trained in ophthalmic reparative surgery. All ear nose and throat surgeons are trained in reparative surgery of the nose and ears. The maxillofacial surgeon is trained in reparative surgery about the face and jaws. The work of these three specialists is closely related and overlaps to a considerable degree. Ofttimes one cannot function efficiently without the skilled help of the others. For these reasons it is believed that a decidedly greater degree of efficiency would be attained in the centers were the three specialties combined into one service that is with one coordinating head or chief of service who would be in charge of the three independently functioning sections.

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groups of men are frequently examined and the inequalities in the training and experience of medical examiners in various sections of the country have resulted in the overlooking of many disqualifying otolaryngologic defects. As a result our present Army contains many substandard men. It is feared therefore that the experience of World War I will be repeated and that there will be again a large number of men suffering from chronic diseases of the ear and sinuses requiring hospitalization or prolonged dispensary treatments. These chronic conditions in the majority of instances have existed for many years—certainly prior to the entrance of the men into the military service. It becomes evident that otolaryngologic surgery in the Army will be increased and with few exceptions will approximate more closely that of civilian life.

In the military service the medical officer has a duty not only to his soldier patient but also to the government. He must consider the interest of the service as well as that of the individual before he does certain types of surgical operations. For this reason it is considered best to do as few radical mastoidectomies and radical sinusotomies with the exception of the maxillary as possible. It is felt that those soldiers who had chronic purulent discharges from the ears or sinuses accompanied by extensive tissue changes prior to entrance into the military service should preferably be discharged for physical disability.

**Tonsillectomies**—Another peculiarity in the military service is the large number of tonsillectomies done on account of repeated attacks of tonsillitis. The age group, the sudden change of climate for many soldiers, fatigue, exposure, the tendency to ignore early symptoms, the crowding in barracks, and the close contact all favor attacks of recurrent tonsillitis. There are no available statistics for tonsillitis in the Surgeon General's Office for the present emergency since in the monthly reports tonsillitis is grouped under acute upper respiratory diseases and there has not yet been time for rendition of the annual report. During the war of 1914-1918 there were 141,067 primary admissions to sick report for acute tonsillitis for troops.

in this country alone exclusive of the American Expeditionary Force from April 1 1917 to December 31 1919 The number of tonsillectomies done at that time was very large but exact numbers are not available because one or more monthly reports from almost every hospital failed to reach the Surgeon General's Office Personal communications from the various camps of our present army show an incidence of tonsillitis which approximates that of World War I

The operative technic for tonsillectomy depends on the personal preference of the individual operator Generally it may be said that local anesthesia and some modification of the wire and snare method are used Tonsillectomy patients should be retained in the hospital for about a week after the operation They must not eat at their regular mess or carry out military duties during that period It would be demoralizing for them to loaf in their quarters Late or secondary tonsillar bleeding may occur if the soldier is returned to duty too soon

**Accidents in Camp and Field**—Injuries incident to boxing and other sports as well as accidents that occur while the men are in training are treated according to the accepted methods of civil life In the military service fracture of the nose and other injuries to the face are seen earlier before swelling has taken place and therefore such fractures can be reduced earlier and better results achieved The effect of gunfire on the ears will be discussed subsequently under War Surgery

**Special Instruments**—Before this phase of the subject is dismissed it might be added that each otolaryngologic service under a competent chief of large experience The surgical equipment and instruments are adequate The suggestion is made to those otolaryngologists who feel that they must have their particular type of forceps rare curet punch or other instrument that they bring such instruments and appliances with them from their personal collections Certain nonstandard instruments may no longer be procurable in this country If they are available they must be specially requisitioned and may not reach the hospital until after the particular otolaryngologist who desires them has been ordered to another station

**Present Status**—To enable surgeons to form some idea of the extent of the operative work done on the ear nose and throat in our new training camps of this country letters of inquiry were sent out. The replies showed that during the early part of this year only emergency surgery and a very limited number of elective operations had been done. The limited field was attributed to the prevalence of acute upper respiratory disease, lack of beds, incompleteness of operating rooms, and so forth. However, since these replies have been received, more normal conditions have prevailed, so that almost all diseases and defects that exist in civil life, and the operations for their correction, are also to be seen in the military hospital today. The great majority of these soldier patients and their newly commissioned surgeons have all been civilians within the year.

## II. WAR SURGERY OF THE EAR, NOSE AND THROAT

War surgery of the ear, nose and throat does not mean any special type of surgery. It simply means the application of the principles of good surgery to battle and air bombing casualties. It is concerned largely with infected, penetrating, perforating and mutilating wounds, compound fractures, foreign bodies, hemorrhage and shock. It deals also with the deafness that results from the special vulnerability of the ears to the vibrations and sudden variations of pressure resulting from gunfire explosion and concussion.

**General Surgical Principles**—In World War I the otolaryngologist in the United States Army was not called upon often to treat these battle casualties. Usually the general surgeon, the faciomaxillary surgeon, or the brain surgeon relieved him of the responsibility. If the otolaryngologist intends to play a greater role in the future, he must familiarize himself with modern general surgical principles, know a few simple facts about the related specialties, and be familiar with the particular problem presented by each of these special regions.

Careful preoperative and roentgen studies are necessary to determine the nature and extent of damage caused, and how

far treatment must be carried out so that the surgeon can prevent unnecessary harm at operation. Attention is to be given to hemostasis, relief of pain, warmth, administration of fluids, blood plasma, blood typing for later blood transfusions, tetanus and gas gangrene anti serum for prophylaxis, and chemotherapy with sulfathiazole or the newer drugs depending on the organisms present. Wounds are to be cleansed and foreign bodies as well as loose fragments of bone and cartilage if denuded of periosteum or perichondrium should be removed. All devitalized tissue should be excised with primary suture only in the limited number of recent injuries that are not deep or extensive. In the larger wounds after debridement and the use of antisepsis and chemotherapy supporting sutures should be introduced with emphasis on free drainage.

**Nose and Sinuses**—In addition to the general surgical principles already enumerated a few points applicable to particular regions may be suggested. In nasal injuries if the bony and cartilaginous portions of the nose are involved the surgeon should save all of the loose bone and cartilage to which there is still an attachment of periosteum in order to build up the framework as much as possible and to make easier the plastic reconstruction later. In cases of injury of the nasal meatus large soft rubber tubes should be introduced to maintain patency. The nasal septum and turbinates should be replaced if possible and care taken to keep denuded surfaces apart. Septal hematomas should be incised early to avoid suppuration and necrosis of cartilage with resulting deformity and even meningitis.

In the maxillary sinuses counterdrainage through the nose should always be instituted. Great care should be exercised in all manipulations about the ethmoid and sphenoid sinuses for fear of meningitis and injury to the intracranial structure. In the case of frontal sinuses the depressed fractures should be elevated and drainage through the nose undertaken. Money<sup>4</sup> stated that if when fragments are lifted the dura is exposed and is seen to be bluish or yellowish—even if it is not lacerated—the surgeon must recognize that a subdural hematoma is

likely to be present. The dura should not be incised through an infected wound only through a clean wound and the blood and pulped brain substance allowed to escape. Any bleeding that occurs from an associated lacerated venous sinus is best controlled by a piece of hammered out muscle graft kept in place for about ten minutes by digital pressure over cotton wool patties until it has stuck fast. Before the graft is applied to the sinus the intracranial venous pressure may be lowered by raising the patient's head. At times it will be necessary to liate or pack the sinus.

**Soft Parts of Mouth and Throat**—Injuries to the soft parts of the mouth and throat are best treated by debridement with retention sutures if the edges of the wound cannot be approximated by free drainage and frequent change of dressings. Later mechanical appliances must be devised to be used as splints to retain position and contour. It must not be forgotten that the patient should be fed through a nasal feeding tube.

**External Ear**—Wounds of the external ear are treated conservatively by primary suture to prevent great loss or deformity with no penetration of cartilage by the sutures. The plastic reconstruction of an outer ear is very difficult. In wound of the external auditory meatus after the removal of the foreign bodies the walls should be replaced and rubber tubing of the same caliber introduced for about forty-eight hours to retain the patency of the canal as well as to afford drainage and prevent later stenosis. Penetrating wounds of the mastoid and temporal bone are treated in general as outlined except that since the introduction of the sulfonamide drugs operation can be delayed until the patient is well over shock and one can wait as long as forty-eight hours.

In all injuries to these special regions it must be realized that the injuries from missiles or projectiles do not confine themselves to the areas of this particular specialty but are frequently associated with complicating injuries more dangerous to the patient's life especially skull fracture and brain injuries. According to German statistics of casualties in the present war two third of all their battle fatalities resulted from this class

of injuries. Therefore it is believed to be best to segregate these patients in special hospitals or at least to have special teams to deal with this class of battle injuries.

**Larynx**—Injury to the larynx usually results in death and therefore must be considered as an emergency from the start. Everyone connected with the case beginning with the litter bearers should be made to realize the gravity of this emergency. The patient should not be permitted to talk and should be given morphine and atropine as soon as possible. No food or drink by mouth should be permitted since the esophagus might also be injured. Falk suggested that it is best to carry the patient with the head bent backwards since this causes pressure of the larynx against the cervical spine thus widening the airway. This position permits easier breathing and helps to control the bleeding by compression. The associated hemorrhage might be controlled by compression of the carotid artery against the transverse process of the sixth cervical vertebra with local tamponade and possibly ligation of the damaged vessel. If the bullet or other fragment has made a hole in the trachea the wound should be cleansed and according to Falk a cannula should be inserted through the opening. It is better and safer to do a preliminary tracheotomy in all cases. Hemorrhage and rapid asphyxia are the first considerations for treatment and later such complications as subcutaneous emphysema, cervical and mediastinal infections and pneumonia. Despons<sup>9</sup> says that the tracheotomy should be done very low just above the sternal notch to diminish the risk of emphysema and mediastinitis.

The exploration as well as the debridement of the laryngeal wound should be conservative. If there is an endolaryngeal hemorrhage which cannot be controlled by any other means a thyrotomy is suggested. It will permit excision of the damaged mucosa and control of the bleeding there by tamponade or ligation. The wounds should never be sutured but should be drained liberally with frequent aspirations and change of dressings. The esophagus should be explored for any damage and a feeding tube inserted through the nose. The patients who



recover will require prolonged treatment on account of the resulting steno is to the airway

Fortunately in modern warfare laryngeal injuries are rare the rate being not more than 3 per 1000 The chin and forward projection of the anterior thoracic wall seem to protect the larynx

#### DETONATION INJURIES OF TYMPANUM AND LABYRINTH

Ear injuries from indirect trauma not due to missiles but as a result of gun explosions or detonation of high explosives comprise a large group of military accidents As these injuries can be considered an occupational hazard a longer discussion of them is warranted

**Rupture of the Ear Drum.**—Colledge quoting Zuckerman in a recent experimental study of blast injuries stated that the detonation of high explosives produces a wave of compression and then a suction There is first a wave of high pressure followed by a wave of negative pressure because the wave of compression reduces the density of the air behind it The two together constitute the blast—the pressure component is the more powerful and shorter of the two whereas the suction component is weaker and of longer duration An ear drum might withstand the force of compression and then be ruptured by the sudden action of the suction in the opposite direction and for a longer period or the rupture might be caused by compression and the eversion by the following suction Wathyn Thomas commented that the above effect of high explosives that is alternating wave of pressure and suction can readily be imagined from the approximately equal number of windows blown in and blown out that a person sees when he walks through a bombed area

Collier in a discussion of her experiences in Barcelona with air raid bombardments stated that Trueta had made studies of blast effects on the middle ear and had found that they vary according to the explosive capacity of the bomb and the distance of the victim from the explosion Medium bombs of 100 to 300 pounds rupture the ear drums within a radius of 50

feet from where they strike of all those who survive the explosion. He found that the tympanic injuries were more frequent in men than in women probably because the latter are more likely to cry out at the approach of a bomb thus maintaining the balance of atmospheric pressure on both sides of the ear drum. The practice of placing a pipe or a pencil between the teeth when the fall of a bomb seemed imminent was found to diminish the incidence of tympanic injuries and was widely employed both in the cities and at the front. Partitions and walls of buildings protected the individuals against blast effects and because of them the percentage was reduced to 0.5 per cent as compared with 40 per cent of those injured in the street. This experience is at variance with the impression gained during World War I that when a soldier was confined in a space such as a dugout both ears drums frequently ruptured while if outdoors only one ear drum was injured.

The shapes and varieties of ruptures vary from stellate linear angular transverse to quadrilateral and the edges vary from irregular ragged to everted. In some instances large portions of the drum have entirely disappeared. Negus has made the important observation that no rupture or perforation ever results in Shrapnell's membrane. The damage was always to the tense portion of the membrane. This knowledge is very important because if a man claims that the condition of his ears is due to explosion and yet the perforation is found to be in Shrapnell's membrane the surgeon can be certain that the claim is without basis.

Trueta reported as the results of his experiences in the Spanish Civil War that of all persons who were the victims of high explosives 30 to 60 per cent also have suffered rupture of the ear drums. The lesions often have been overlooked and consequently neglected until suppuration with its complications of mastoiditis loss of hearing and so forth has occurred. Surgeons are therefore urged to examine the ears of all head and blast casualties as soon as their general condition permits in order to make an early diagnosis and to institute proper treatment.

Practically all surgeons agree that such a ruptured ear drum should be treated similarly to one caused by a skull fracture. It should not be syringed and nothing should be introduced into the deeper portions of the canal. Only a plug of sterile cotton should be put in the external auditory meatus and changed as frequently as necessary. The patient should be put to bed. In the Spanish Civil War in over 200 cases of ruptured ear drums treated conservatively only two instances of chronic suppuration have resulted.

**Labyrinthine Injuries**—That damage occurs to the inner ear from the detonation of explosions has been amply proved by experimental anatomical and clinical observation. Colledge<sup>7</sup> stated that Prenant and Castex in 1916 submitted rabbits and guinea pigs to artillery fire. They found the organs of Corti disorganized principally in the first and second turns of the cochlea, hemorrhage, atrophy and shrinking of the nervous elements. The static portion of the labyrinth however remained intact. Stanger subjected rats to blows on the head of varying degrees of violence. The labyrinth was examined in those animals in which there was no fracture and hemorrhages were found in the cochlea principally in the neighborhood of the round window and the first turn of the cochlea.

Lurie has demonstrated that in guinea pigs the organ of Corti is thrown off the basilar membrane by the use of sudden intense sounds (120 decibels) the pitch being 400 cps. He also showed that the external hair cells resting on the vibrating basilar membrane are affected first while the internal hair cells resting on bone are less subject to the vibration of the basilar membrane. He showed too that a degeneration of external hair cells causes loss of hearing of about 20 to 30 decibel and that the internal hair cells are the chief functioning sensory cell in the perceptive type of deafness. The internal hair cells respond to intensities between 30 and 40 decibel above threshold. Briefly then a catatrophic degeneration of the external hair cell causes slight loss, a more general degeneration greater loss and complete deafness results from degeneration of both internal and external hair cells. The conception that

nerve (perception) deafness is due to actual involvement of the sense organ or the nerve itself has been amply proved by numerous investigators Fraser<sup>7</sup> made microscopic examinations of human ears in four fatal cases and found hemorrhage at the fundus of the internal auditory meatus in three cases in which the fine branches of the cochlear nerve entered the modiolus. The lesions may be similar to those of the olfactory nerves in fractures of the anterior fossae of the skull.

Though treatment for the deafness resulting from ruptured ear drums is satisfactory no such effective treatment is possible for injuries of the inner ear because in such injuries there is an irreparable damage to the organs of Corti and frequently an associated damage to the brain. Unfortunately there is no way to help this type of deafness by treatment or any known type of hearing aid.

**Preventive Measures —Silencers or Mufflers —**The question comes to mind—can such injuries to the middle and inner ear such as have been described be prevented and how can they be prevented? The first thought is to have this blasting sound stopped at its source to do this it would be necessary to put silencers or mufflers on all guns especially those of a larger caliber so that the ears of the members of the gun crews would be protected. The Ordnance experts claim that this action is impracticable and would impair the efficiency of the gun furthermore they state that no type of silencer even for the smaller weapons has been approved by them to date. In addition to the danger presented by sounds from guns and explosives the Germans have introduced other terrifying screeching sound made by dive bombing and shells which produce a demoralizing effect. Nature has well protected the inner ear against direct external trauma by locating it in the solid portion of the temporal bone but has not been fit to provide it with an automatic voluntary defender against excessive noise comparable to the eyelids which shut off excessive light. It becomes evident therefore that the only hope lies in the invention of efficient protection to the ears namely ear defenders.

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Knudsen gave figures of high insulation as measured in decibels with a Sonotone audiometer for these protectors. The writer tested persons of higher than average intelligence with these same plugs after he had given them the two sizes with the printed instructions from the manufacturer as to their insertion. The hearing was tested for all frequencies with a Maico audiometer before and immediately after the insertion of the plugs. It was found that the degree of insulation varied among those examined but when it was averaged the degree of insulation obtained by the use of these defenders was not impressive. The disappointing results were believed due to some extent to the improper insertion of these plugs because of failure to carry out instructions carefully. Undoubtedly the main reason for the unsatisfactory results was the impossibility of making these soft rubber plugs fit the different sizes and shapes of the orifices of the external auditory canal. This defect appears to be inherent in all ear protectors which have to be inserted into the ear canal.

Guild has devoted a great deal of time to the study of this subject. He favored the device manufactured by a British firm during the war of 1914-1918 named the Scientific Ear Drum Protector Tommy. He has proved in the experimental testing of the efficiency of the various devices by histologic examination that dry cotton was the least effective of them all in stopping small detonation waves. Yet our troops prefer and use dry cotton almost to the exclusion of all other forms of ear protection. It is noted that a finger tip placed firmly in the external auditory canal is a simple and effective method and can always anticipate the needs of the ear hand. The most critical ear defender which has not been discovered yet is the genius of our scientific mind. At least some of the existing devices used in field trials in which the basis suitable ac-

**Ear Defenders**—During the war of 1914–1918 a thorough study was made of this subject and various types of protectors were tested but no definite action has been taken to adopt any of them. Personal communications from the various Camp Surgeons throughout the country including Aberdeen Proving Ground Maryland revealed that only cotton cotton waste gun cleaning patches or the index finers are used to block the ears. Because there is no official prescribed or required precaution in many camps nothing at all is used to protect the ears.

Our Air Corps has given up all devices which have to be inserted into the external auditory canal and are experimenting now at Wright Field with helmet flap. Davis stated that oil cotton wool or coarse fiber plasticine wrapped in gauze is the most comfortable but the majority of soldiers prefer to stop their ear temporarily with the index finer. Some obturator made of inflammable material which have been used by the British have caught on fire from the flash of a gun. The Spaniards have used an ear protector on the lines of the Mallack Armstrong defender. It consists of a small plug with a valve that remains open except when the external pressure is increased. The rubber plug defenders distributed in England as part of the Air Raid Precautions have not been designed on similar lines and Collier laments that they are not as efficient as the Spanish.

Knudsen made a study of all types of ear protectors available to him in the United States and in Europe. He searched the patent and technical literature and consulted numerous authorities on the subject. He failed to find a single ear defender that appeared to be designed in accordance with acoustical transmission theory. He devised a defender called M S A Ear Defender manufactured by the Mine Safety Appliances Company, Pittsburgh Pennsylvania. This defender is essentially a tapered rubber tube containing an outer barrier of heavy metal and an inner barrier of soft rubber. There are thus two barriers or partitions—operated by an air space—through which the noise must penetrate before it can strike the ear drum.

## PLASTIC AND MAXILLOFACIAL SURGERY

ROBERT H IVY M D F A C S

C O M M E N T A R I E S C U R R E N T S E S A I E M O C  
 S U R G E R Y N A T I O N A L R E S E A R C H C O U N C I L P  
 M A X I L L O F A C I A L S U R G E R Y S C H O O L O F M E D I C I N E U N I V E R S I T Y F P N  
 Y L I A

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THE term Plastic Surgery denotes a branch of surgery in which the shifting or readjustment of tissue is undertaken for the treatment of congenital or acquired deformities for the improvement of function comfort appearance or contour. In its general acceptance it is commonly limited to restoration or adjustments of any of the tissues of the face and its appendages the mouth excepting the teeth also the female breast and external genitalia and the skin and subcutaneous tissues of the entire body. This is the definition adopted by the American Board of Plastic Surgery.

### SUBCOMMITTEE ON PLASTIC AND MAXILLOFACIAL SURGERY NATIONAL RESEARCH COUNCIL

Early in 1940 the Division of Medical Sciences of the National Research Council was requested to form a Committee on Surgery for the purpose of advising the Surgeons General of the Army Navy and Public Health Service on surgical problems arising in connection with the national emergency. The writer was invited to be a member of this Committee to represent the field of plastic and maxillofacial surgery. Subsequently a Subcommittee on Plastic and Maxillofacial Surgery was formed with the writer as chairman to co operate with those representing the Surgeons General in this particular field.

**Personnel**—The members of the Subcommittee in addition to the author are John Staige Davis M D Baltimore Maryland Ferris Smith M D Grand Rapids Michigan Percy C Lavery D D S Detroit Michigan and Joseph D Eby D D S New York City. The members of the Government





# PLASTIC AND MAXILLOFACIAL SURGERY

ROBERT H IVY M D F A C S

C O M E D I C A L R E S I D E N T C U N I V E R S I T Y A M E R I C A N  
I N S T I T U T E O N S U R G E R Y N A T I O N A L R E S E A R C H C O U N C I L P O S T  
M A X I L L O F A C I A L S U R G E R Y S C H O O L M E D I C I N E U N I V E R S I T Y O F P E N N  
S Y L A N I A

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services with whom we have been most directly working are Brigadier General Leigh C. Fairbank, Dental Corps, U. S. Army, Assistant to the Surgeon General; Colonel Norman T. Kirk, Medical Corps, U. S. Army, Chief of the Surgical Service, Walter Reed General Hospital; Lieutenant Colonel Roy A. Stout, Dental Corps, U. S. Army, Chief of Oral Surgery Section, Walter Reed General Hospital; and Commander Frederick R. Hook, Medical Corps, U. S. Navy, Chief of Surgical Service, U. S. Naval Hospital, Washington, D. C.

From time to time as circumstances demanded other members of the Government services and the National Research Council have sat in the meetings of our Subcommittee. It will be noted that the Subcommittee and its Government associates include representatives of both medical and dental professions. It has long been recognized that the best results in the treatment of injuries involving the maxillofacial region can be obtained only by close collaboration of the surgeon and the dental surgeon, and for this reason any farsighted planning for the care of these cases in wartime must be done by joint action of surgeons and dentists.

**Objectives**—The principal problems to engage the attention of the Subcommittee and the interested Army and Navy officers are as follows:

1. The formulation of a definite plan of treatment of face and jaw injuries from the first aid stations to the general and special hospital in the rear.
2. The assignment of properly trained personnel to the various units through which such injuries would pass.
3. The provision of proper special equipment and instruments needed for the treatment of these injuries.
4. The estimation of the number of specially trained medical and dental officers who will be required for this work, and the ascertainment as far as possible of the number of already available trained personnel in civilian life.
5. The preparation of a section on the treatment of face and jaw injuries for the emergency manual to be published by the War Department.

6 The preparation of a special Manual of Maxillofacial Surgery to be used specifically in the training of those to be assigned to the treatment of injuries of the face and jaws and as a guide in the treatment of these cases

7 The planning of special courses of training in the care of face and jaw injuries to which medical and dental officers will be assigned

These activities are well advanced at the present time and some of them have been completed. The *Manual of Maxillofacial Surgery* regarded as our most important and urgent objective under the able leadership of Dr. Ferris Smith is now ready for publication and will be the first of the surgical manuals sponsored by the National Research Council to appear in print.

**Suggested Principles of Management**—In the formulation of principles underlying the care of injuries of the face and jaws the best experience with both military and civilian practice here and abroad has been consulted and in the instructions to be given those chosen to care for these cases in our military forces certain definite rules have been laid down. A correlated plan of treatment if carried out from the advanced zone to the installations in the rear will greatly shorten the period of disability of patients with face and jaw injuries and a larger number will be restored to approximately normal function and appearance than if haphazard methods are followed. At the time of World War I most of our preparations for care of these special cases were made under the able leadership of Colonel Vilray P. Blair after the United States entered the conflict. In the present emergency should war be declared our plans to care for these cases are well under way and I am of the opinion that we have many more and better trained surgeons and dental surgeons than were available in the war of 1914-1918.

The most efficient treatment of face and jaw injuries entail close cooperation between officers of the medical and dental corps. The general care of the patient the problems of wound infection and tissue repair will be largely in the hands of the

medical officer or plastic surgeon while the special problems of fixation of jaw fractures and care of the mouth and teeth lie within the field of the dental oral surgeon. These two men however are not to be regarded as working separately. Each must have an understanding of what the other does so that the treatment will merge into a homogeneous entity. Provisions are being made for the assignment of properly trained medical and dental personnel and special equipment to various hospital installation.

Instructions are being prepared for the special care of these injuries from the first aid stations back to the general hospital. It is realized of course that modern mobile warfare may entirely disrupt tables of organization planned in advance. But some kind of preparation has to be planned and adhered to when circumstances permit although it should be sufficiently elastic to allow for modifications. It is also understood that specialists in the care of facial injuries cannot be assigned as such to the advanced regimental aid stations. However instructions as to what should be done there and what should not be done will be given to commissioned and enlisted personnel attached to these advanced posts so that those suffering from face and jaw wounds will arrive in the best possible condition at the hospitals in the rear. Such a program will probably save many lives and facilitate the later treatment of face and jaw wounds by the specialists.

*First Aid Packet*—Every officer and enlisted man of the medical department in the combat zone is supplied with equipment useful in rendering first aid treatment for jaw injuries. The first aid packet adapts itself admirably for jaw fractures and can be applied suitably to a great many types of gunshot wounds of the face and head. The compress sewn to the central portion can be made to serve as a hammock or sling to support the injured structures. If the attached bandage is torn lengthwise the dressing becomes an ideal four tailed bandage which may be satisfactorily applied and secured. The compress itself can be separated from the bandage and used as an extra packing dressing or support over any region. The safety pins in the first aid packet help to make the dressing secure.

## TREATMENT OF MAXILLOFACIAL WOUNDS IN THE COMBAT AREA

In the combat area the following points demand special attention

1 *Arrest of Hemorrhage*—It may be possible to check hemorrhage temporarily by digital pressure over an artery proximal to the bleeding area. The principal points of compression about the head and neck are *external carotid artery*—beneath the anterior border of the sternomastoid muscle just above the level of the thyroid cartilage *facial or external maxillary artery*—lower border of the mandible  $\frac{3}{4}$  inch in front of an *inferior facial temporal artery*—just in front of the tragus of the ear. Moderate hemorrhage from a wound about the jaw can usually be checked by pressure from a gauze pack inserted in the wound and held in place by a four tailed bandage. Care must be exercised in the application of the pack and bandage so as not to increase any respiratory difficulty occasioned by the nature of the wound itself. Hemorrhage that cannot be checked in this way demands a search for the bleeding vessel and application of a clamp to it followed by ligation if ligature material is available otherwise the clamp should be left on during transportation of the patient to the advanced hospital.

2 *Provision of Adequate Respiratory Airway*—Loss of bone and muscle attachment frequently results in loss of control of the tongue with danger to respiration. This danger is best controlled by use of a long suture through the tip of the tongue. The suture should be long enough to draw the tongue forward and may be attached to the dressing or clothing. If a needle and suture are not available the tip of the tongue may be transfixed with a large safety pin. A piece of gauze or bandage may be attached to the tongue suture or safety pin for traction to improve and clear the air passage. These considerations are particularly important if the patient is unconscious. In other cases due to swelling of the soft tissues sufficient airway can be provided by insertion of a rubber tube through the nose or mouth to the nasopharynx. If these means are not adequate tracheal puncture through the skin with a special trochar will usually save the situation. It is hoped that these tracheal

trochars will be added to the emergency kit. Tracheotomy should be considered only as a last resort since it is followed by a high mortality in cases of this type.

3 *Temporary Approximate Reduction and Fixation of Bone Fragments*—If a dental surgeon is available and time permits he should be assigned the problem of temporary fixation. Each dental surgeon at advanced stations is provided with an emergency maxillofacial kit which contains instruments and materials for emergency dental operations and for application of temporary fixation of fractures of the jaws. Intelligent emergency treatment reduces the period of hospitalization and ensures far greater success in subsequent treatment with a minimum of deformity.

Early treatment should ensure every chance for restoration of the original occlusion of the teeth or the restoration of the function of mastication even in those cases in which a considerable amount of bone has been lost. It is particularly important that the collapse of bone segments be avoided. In order to minimize infection early cleansing of the wound is important. Tooth fragments, foreign matter, completely detached particles of bone and so forth should be removed. Often overenthusiastic débridement is instituted with the result that bone fragments which still possess periosteal attachment are taken away. Bone fragments which have any attachment to the soft tissues should be allowed to remain as they frequently keep their vitality and aid in restoring continuity of bone. It is much wiser to leave a bone fragment of doubtful vitality and remove it later in case of necrosis than to perform a radical removal of all loose pieces of bone because of the resultant defects that may require bone grafting later.

Reduction of fragments by manipulation and temporary fixation by the use of simple measures such as bandaging and elastic traction should be done if possible at this time. Teeth of the same jaw may be wired across the line of fracture in some cases to maintain fragments during evacuation of patients to the rear but fixation of the lower to the upper teeth should never be done prior to unattended travel. Fixation and stabiliza-

zation of fragments at this stage of the treatment help to reduce pain and shock. They also assist in the control of the tissues essential for the maintenance of a clear air passage and reduce the danger of recurrent hemorrhage.

Military conditions may permit the application of some of these fixation measures by the dental officer in the combat zone. If they do not, the application of fixation measures must be deferred until the wounded man reaches the surgical hospital or the evacuation hospital. Special apparatus and methods of fixation of jaw fractures by the dental officer are described in the section on Dental Surgery.

*4 Provision of Dependent Drainage*—The closure of soft tissue wounds about the jaws by suture is rarely possible at the battalion aid stations, but should such occasion present itself, officers are warned never to close a wound that communicates with the lower jaw or with the oral cavity without the provision of adequate dependent drainage. In those cases in which this fundamental precept has been ignored, disastrous results from overwhelming infection have followed frequently. After stabilization of bone fragments, if a large gaping wound is present, it is best not to try to close it but to cover exposed bone ends by suturing edges of skin to oral mucous membrane. The wound is kept wide open and collapse of the bone fragments is prevented. This procedure will minimize infection of bone and soft tissues and will conserve tissue for future repair.

*5 Provision of Safe Transportation from the Combat Zone to Hospitals in the Rear*—Casualties must be prepared for safe unattended travel by hospital train to general hospitals. Aside from problems of nourishment, sedation and prevention of shock, special considerations apply to face and jaw injuries. One of the lessons learned in past wars was that ambulant or semi-ambulant patients with oral or pharyngeal wounds should sit up during evacuation. If he must be recumbent, the patient should be placed face downward to obviate the danger of obstruction in the air passages. On the litter, he may be placed with the forehead resting on the strap, a space being thus left between the strap and the litter proper for the escape of secre-



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with the exception of bone fragments with soft tissue attachment

3 Bone fragments are fixed in approximately normal position by wires on the teeth extraoral appliances and so on

4 Devitalized soft tissue is cut away and torn flaps of tissue are restored to approximately normal positions. Edges of the skin and mucous membrane are sutured to cover raw surfaces and exposed bone. Never suture soft tissues over collapsed bone fragments

5 Dependent drainage is applied to wounds communicating with the mouth or with bone fragments

6 Sulfanilamide is administered internally and sulfanilamide powder is applied locally to the wound surface

#### TREATMENT OF MAXILLOFACIAL WOUNDS AT THE BASE HOSPITALS

The time required for the wounded to reach the general hospital which may be situated 100 miles or more to the rear of the combat zone varies considerably. The desirability of rapid evacuation to a place where definitive treatment can be given is obvious. The measures already outlined if carried out properly will insure the arrival at the base of a large percentage of patients with jaw injury in good condition for definitive treatment

In the general hospitals every possible facility in the way of equipment and special personnel is provided for the proper care of these cases. Each case will be examined jointly by the surgeon and the dental surgeon and a plan for its treatment outlined. In the interval between receipt of the wound and arrival at the general hospital the onset of infection is to be looked for hence *measures for combating infection* constitute one of the first considerations on arrival. Wounds should be carefully revised, foreign bodies previously overlooked should be removed, abscesses opened and proper drainage established. Local and general chemotherapy should be employed when indicated by cultures. Roentgenologic examination will reveal foreign bodies, fractured teeth, displaced bone fragments, and

tion and discharges from the mouth. These precautions less en the mortality rate of jaw injuries during evacuation.

The most advanced organization to which it is contemplated that specialists in the care of face and jaw injuries will be attached is the *surgical hospital*, a mobile unit operated in connection with the clearing station located seven to ten miles to the rear of the front line. Each surgical hospital according to the plans will have a *maxillofacial team* consisting of a surgeon and a dental surgeon trained in the special requirements of treatment of these injuries. Here more detailed examination of the wound can be given and the patient prepared for safe evacuation to the base. *Hemorrhage* is permanently controlled by ligation of important bleeding points and general measures for the treatment of shock are applied. A more thorough *cleansing* of the wound of foreign matter, detached bone fragments and shred of devitalized soft tissue is carried out and more stable *fixation of bone fragments* is applied. Some attention can then be given to the *suturing* of large displaced flaps of soft tissue or to the *suturing* of skin to mucous membrane in gaping wound communicating with the mouth. In these procedures the principle of avoidance of collapse of bone fragments by contacture of soft tissue should be always kept in mind and dependent drainage should be provided. *Debridement* is not carried out as completely in wounds of the face as it is in wounds of other parts of the body since the vascularity of the parts of the face enables them to resist infection to a greater extent. Experience in the treatment of facial wounds in Europe indicates the great value of the *sulfonamide drugs* in preventing and combating streptococcus and other infections both when they are taken internally and when they are applied locally to the wound.

#### Summary of Treatment at Advanced Hospital—

- 1 Hemorrhages permanently controlled by ligation.
- 2 The wound is cleansed and all easily discovered foreign bodies completely detached bone fragments and teeth and loose teeth and bone connected with fracture lines are removed.

with the exception of bone fragments with soft tissue attachment

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other matter. As the acute inflammation subsides, more permanent appliances for reduction and fixation of bone fragments may be made.

The important principle of *early reduction and fixation of bone fragments* should always be observed before attempts at permanent soft tissue repair are made. The collapse of underlying bone fragments will thus be prevented. In many of the simpler cases of fracture of the jaws, fixation can be maintained efficiently by wires applied to the teeth, combined with elastic traction. For the more complicated cases, especially those entailing considerable loss of bone and a prolonged period of fixation, special plints have been devised. Personnel and equipment for their production will be assigned to the general hospital. The dental laboratory will also be prepared to furnish various appliances for the support of skin grafts, as well as other aid to the surgeon.

After the infection has cleared up, the problem of *repair and replacement of lost tissues* is to be considered. The soft tissue repair by means of flaps, grafts, and other devices may often be undertaken while the fractures are undergoing treatment. In about 10 per cent of gunshot fractures of the lower jaw, there is so much loss of bone substance that nonunion results in which instances there is the necessity for bone grafting. No attempt at bone grafting should be made until at least three months after disappearance of infection from the region of the injury.

The final steps in the restoration of these patients are the provision of *artificial dentures* to replace lost teeth, and *prostheses* of various kinds to substitute for missing parts that cannot be restored by surgery.

In conclusion we again wish to emphasize that in preparations for the care of face and jaw injuries, an endeavor is being made to put into effect a continuous logical plan of treatment to be followed from the combat zone back to the final phases of reconstruction—the general or the special hospital.

SURGERY OF THE CHEST

FREDRIC L CONKLIN M D F A C S

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In only a short period of time the accomplishments in thoracic surgery have been epoch making and in reviewing the literature one is impressed with the remarkable lowering of the mortality rate in this new field of surgery. It was not until 1933 that the first lung was removed but with this accomplishment as a stimulus there has been an increasing number of pneumonectomies until today all large clinics follow this line of treatment.

It was during the period from 1933 to the present that the foundation for modern thoracic surgery was established with the result that practically every disease affecting the chest now can be successfully treated surgically. It must be remembered however that these spectacular advances could not have occurred had it not been for the improved technic in anesthesia, the well established procedures of bronchoscopy, esophagoscopy, thoracoscopy and bronchography, and our knowledge of the dynamics and physiology of the thoracic cavity. We have known for some time that maintenance of intracranial pressure balance in intracranial injuries is essential to the life and function of brain tissue and the individual. Likewise we have learned more recently that an unbalance in intrathoracic pressure with a visceral shift may be incompatible with the physiology of the thoracic viscera and result in death. The dynamic and physiology of the chest must be understood in order to care for thoracic injuries successfully and these dynamics must be heeded whenever the chest is operated on.

Elective thoracic surgery should be performed by a surgeon

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other matter. As the acute inflammation subsides more permanent appliances for reduction and fixation of bone fragments may be made.

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**Shock.**—Shock which is usually severe in chest injuries must be treated immediately and before any surgery is resorted to the systolic pressure should be 90 mm of mercury or more the exception to this being in the case of hemorrhage. During World War I it was demonstrated that morphine heat transfusion and the immobilization of fractures when present were of paramount importance in the treatment of shock. We now have blood plasma which has had sufficient trial in the present war to demonstrate its merits. Because of the simplicity of its administration (grouping unnecessary) accessibility (storage and transportation without refrigeration) and the fact that it will keep for weeks I am of the opinion that the use of plasma in the case of shock will do more towards the saving of life than any other single procedure.

Whitby and associates in a survey of serious war and air raid injuries state that the pulse rate is an unreliable diagnostic criterion and that the blood pressure is the most reliable one. Further they maintain that plasma and blood are equally effective in restoring the blood volume. A rise of from 10 to 20 mm of mercury for each pint of blood or plasma given is expected.

Broster states that for shock and loss of blood plasma or blood should be given in large quantities from the start often as much as five or six pints the aim being to maintain the hemoglobin at 80 per cent.

**Hemorrhage.**—Troublesome hemorrhage may come from an intercostal internal mammary or pulmonary vessel and if it is profuse immediate surgical interference is indicated. Bleeding from an intercostal vessel is the least serious hemorrhage and may be controlled by encirclement of the rib with towel forceps on either side of the vessel. Hemorrhage from a pulmonary vessel if at the hilum will probably be fatal before it can be checked however if time and supportive measures permit the lung should be exposed and the bleeding controlled. To do this a lobectomy or pneumonectomy may be necessary. It seems to be the consensus that intrathoracic hemorrhage is intensified and prolonged by the negative pressure.



who specializes in this work but much thoracic surgery can be done by the general surgeon and much emergency thoracic surgery must be done by the general surgeon and general practitioner. Automobiles and industries are daily supplying an increasing number of chest injuries and of course war give the military surgeon the extremes in this class of injuries.

Base hospitals during war should have surgical teams specially trained and experienced for regional work that is to say there should be the thoracic team head team abdominal team orthopedic team and other necessary teams. However it should be understood that the team should be available for all general work if circumstances demand.

Indications for surgery of the chest can be divided into two main groups (1) injuries (2) disease.

### THORACIC INJURIES

In this group we have (a) the injuries which require immediate interference in order to save the patient's life and (b) those which can be treated conservatively but which may require surgery at a later date.

Conditions encountered in this group which may call for surgical interference are:

Shock	Fracture of body
Hemothorax	Wounds of the heart
Tension pneumothorax	Emphysema
Wounds (penetrating)	Traumatic pharynx
Cervical esophageal	Traumatic diaphragm
Chest injury	Chylous thorax
Fracture of the ribs	

It is in these cases that the surgeon's skill, judgment and speed may mean life or death to the patient. The first examination should be gentle, thorough and rapid but time should be taken to outline on the skin the site of the apex beat and other boundaries. Because of the rapid changes which might take place this procedure will be of great value in subsequent examinations especially if the patient is evaluated and seen by another physician.

a needle should be inserted into the pleural cavity and connected to one end of a tube. The other end of the tube is placed in a bottle of water that should be situated two feet below bed level.

The opening of a *sucking wound* should be sealed over until after the shock period has passed, then it should be debrided and closed tightly, thus making it a closed lesion.

Three months ago a patient was admitted to the Surgical Service of the Naval Hospital San Diego with an *empyema* of the left side. Examination disclosed respiratory difficulty, rapid pulse rate and a low grade fever 99.6° F. Roentgenologically a left pyopneumothorax with a tracheal and mediastinal shift to the right was revealed. Thoracentesis with the removal of pus and air which was under pressure brought immediate temporary relief.

In 1938 at the U. S. Naval Hospital Philadelphia I performed a pneumonectomy on a patient with bronchogenic carcinoma of the right lung. The postoperative convalescence was satisfactory until the fifth day when the pulse rate climbed to 150. Respiratory embarrassment was present in spite of the aid of an oxygen tent. X-ray studies showed a marked mediastinal shift to the right and the manometer recorded an increase of negative pressure. In this case the shift was due to *absorption of air* on the operated side which caused hypotension pneumothorax. Air was introduced into the right pleural cavity followed by immediate relief. The patient recovered; a second air injection was not necessary.

**Penetrating Wounds Foreign Bodies Traumatic Empyema**—Kretzschmar in describing the treatment of chest wounds by *artificial pneumothorax* states that this treatment apparently was developed by the Italians in the war of 1914–1918 and has been used by the Spanish during their recent Civil War. He further states that injury of the large bronchi was rare in the war in Spain probably because the projectiles pushed them aside. Any severe injuries catching a major bronchus would also catch some large vessels and the patient would soon suffocate in his own blood before treatment could be admin-

When surgical interference is not possible the blood in the hemothorax should be aspirated and replaced by air a volume of air 300 to 400 cc greater than of aspirated blood being used. During this procedure the patient should be carefully observed for a possible induced tension pneumothorax. A manometric reading of the intrathoracic pressure should be made at the time of air injection. A hemothorax should be aspirated dry the procedure being repeated daily if necessary. I do not agree with some surgeons who are of the opinion that the blood should be left in the chest. After its early usefulness as a tamponade has passed it is of no further value lying in the pleural cavity. It hinders re-expansion of the lung and is a rich medium for possible empyema.

**Cardiac Tamponade**—Cardiac tamponade can be diagnosed by a falling arterial and a rising venous pressure. The fluoroscope will show a diminished cardiac activity and the heart sound will be absent or distant. Treatment should be immediate consisting either of apiration or operation. Following pericardial apiration if the condition first improves and then becomes worse operation is indicated.

**Tension Pneumothorax**.—Tension or pressure pneumothorax with a mediastinal shift calls for immediate action. The shift is due to an increase or decrease of intrathoracic pressure. The increased pressure can be caused by either (1) injury with intrapleural bleeding or sucking wound or (?) *empyema with accumulation of pus and air*. In these conditions the shift is away from the involved side. It is known as a hypertensive shift.

In lobectomy or pneumonectomy there is an absorption of air causing an increase of negative pressure which pulls the mediastinum to the affected side the same as in atelectasis a hypotensive shift. The symptoms coughing restlessness tachycardia and respiratory difficulty—a result due to change in pressure on the large vessels and to ston of the vessel and nerve supply of the cardio-piratory system. If the shift is due to hemothorax or hemopneumothorax conservative treatment such as needling will suffice. If the tension continued after aspiration

Death is probably due to a local visceral shock from which the vital organs do not recover

**Emphysema**—Emphysema unless it is extensive or involves the mediastinum is not serious When operation is necessary the approach is at the site of the fracture so that a laceration in the lung if present can be repaired Mediastinal emphysema calls for immediate relief by means of a supra sternal incision If this does not stop the extravasation of air a thoracic decompression should be done

**Chylothorax**.—Chylothorax is rare and should be treated by aspiration and low fat diet

**Diaphragmatic Hernia**—Diaphragmatic hernia is not an unusual complication and can be diagnosed by x rays Immediate operation is not indicated unless there is strangulation After the patient has recovered fully from the other effects of the injury then hernial repair can be considered

**Summary**—In summary it can be said that the treatment of most chest injuries should be conservative but when intervention is necessary conservative or otherwise it must be resorted to immediately I should like to emphasize the importance of the patient being under constant supervision during the emergency period In cases of shock with hemorrhage plasma or blood transfusions and heat should not be spared Patients in shock when admitted to the Naval Hospital San Diego are placed in bed and the heat from a large electric cast dryer is circulated under the blankets This treatment is found to be far more efficacious than the use of hot water bottles or electric pads as the heat is more evenly distributed and is kept at an even temperature

#### DISEASES OF THE THORAX

Diseases of the thorax which may require surgical interference are

Empyema

Abscess

Brachiectasis

Pulmonary tuberculosis

Atelectasis

Tumors (thoracic and intrathoracic malignant and benign)

istered *Every open wound should be made a closed wound by careful debridement and by airtight suturing* The Spaniards had an oiled silk dressing and elastoplast which were carried in the men's first aid equipment ready for immediate use

A *foreign body embedded in the wound should be extracted and a generous thoracotomy debridement and airtight suture* employed Foreign bodies if not removed may result in serious infection If infection develops the wound should be drained at once

A *fractured rib penetrating the lung should be reduced mobilizing the lung* Fractured ribs and sternum may be held in reduction by towel clips and weight traction This procedure is especially applicable in those cases in which there is a stove in condition

According to Monod *traumatic empyema is best treated successfully by drainage sulfanilamide T A T (toxin antitoxin mixture) and anti gas serum* He states that those patients suffering from traumatic empyema require long periods of observation and should be evacuated to the rear slowly I am sure that sulfanilamide will prove to be of more value when used prophylactically than when used in the treatment of traumatic empyema just as it is in the case of compound fractures

**Concussion Injuries**—Concussion from bombs and explosives in the present war is so great that persons in the vicinity are injured without actually being hit Dean states that evidence of thoracic injury may be seen without any warning symptoms following a blast Routine examination should be made of all who have in any way been involved in bomb blasts The physical signs may be diminished movement of the diaphragm fullness of the chest (giving it an emphysematous appearance) and impairment of resonance at the bases of the lungs Patients frequently exhibit a ballooned appearance especially at the lower costal margins In severe compression injuries of the chest there are varying degrees of visceral involvement that range from rupture of the heart lung or large vessel to contusion of the viscera all of which are fatal However the last named condition reveals negative findings at autopsy

Death is probably due to a local visceral shock from which the vital organs do not recover

**Emphysema**—Emphysema unless it is extensive or involves the mediastinum is not serious. When operation is necessary the approach is at the site of the fracture so that a laceration in the lung if present can be repaired. Mediastinal emphysema calls for immediate relief by means of a supra-sternal incision. If this does not stop the extravasation of air a thoracic decompression should be done.

**Chylothorax**.—Chylothorax is rare and should be treated by aspiration and low fat diet.

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**Summary**—In summary it can be said that the treatment of most chest injuries should be conservative but when intervention is necessary conservative or otherwise it must be resorted to immediately. I should like to emphasize the importance of the patient being under constant supervision during the emergency period. In cases of shock with hemorrhage plasma or blood transfusions and heat should not be spared. Patients in shock when admitted to the Naval Hospital San Diego are placed in bed and the heat from a large electric cast dryer is circulated under the blankets. This treatment is found to be far more efficacious than the use of hot water bottles or electric pads as the heat is more evenly distributed and is kept at an even temperature.

#### DISEASES OF THE THORAX

Diseases of the thorax which may require surgical interference are

Empyema

Abscess

Bronch ectasis

Pulmonary tuberculosis

Atelectasis

Tumors (thoracic and intrathoracic malignant and benign)

**The Bronchoscope in Diagnosis and Treatment**—There are three principal methods of treatment in diseases of the chest namely, medical, bronchoscopic and surgical. Many cases require treatment by all three. Bronchoscopy has done more toward the rapid advancement in the diagnosis and treatment of these conditions than any other procedure. However, it must be remembered that improved surgical technic, pre and postoperative care, anesthesia, roentgenography, with bronchography and pathologic studies have all played their part. By the direct inspection of bronchoscopy, obscure pulmonary conditions can be diagnosed accurately, as a result proper treatment can be outlined. There is nothing of more importance in the diagnosis than to be able to obtain a biopsy specimen bronchoscopically from an endobronchial lesion. The bronchoscope is useful in the removal of foreign bodies and in addition it is invaluable in the treatment of pulmonary abscess, bronchiectasis, atelectasis and localized tuberculosis lesions. Arbuckle and Stutsman recommend its use to determine the cause and location of unexplained bleeding. They claim to have had no unfavorable action and advise that the procedure be carried out while bleeding is active.

**Empyema.**—During World War I we learned much concerning the treatment of empyema. We learned that if thoracotomy was delayed the mortality rate was much lower. There are certain fundamentals in the treatment of empyema which are generally recognized and which should be followed. The empyema cavity should be kept thoroughly evacuated by means of repeated aspirations until the pus becomes creamy and difficult to remove. Then a closed thoracotomy should be performed. By the time this is done adhesions will have formed between the lung and chest wall, localizing the empyema and helping to fix the mediastinum. I believe nothing is gained by irrigation before this stage has been reached. However, at this time tidal irrigation may be necessary to remove any thick pus that blocks the tubing. Adequate drainage must be maintained. A roentgenologic check should be kept on the lung expansion as this expansion must be accomplished before the chronic

empyema stage has been reached. The physician should not hesitate in instituting suction or in placing the patient on bottle blowing if expansion is delayed. When the lung cannot be expanded to fill the pleural cavity the chest is collapsed to the lung by thoracoplasty as soon as the patient is in condition to withstand the operation.

**Abscess**—Pulmonary abscess presents one of the most difficult problems for the thoracic surgeon. The mortality rate for the condition is too high and continued endeavor should be made to lower it. Proper treatment cannot be carried out without an accurate diagnosis as to etiology, location and extent of involvement. To make an accurate diagnosis bronchoscopy, roentgenography and bronchography are indispensable. Lung abscesses like empyema require adequate drainage which can be accomplished either by the conservative method of bronchoscopic aspiration and postural drainage or by surgical drainage. Drainage by thoracentesis should not be performed unless the abscess is large, superficial and the lung is adherent to the pleura, as there is danger of pyopneumothorax and hemorrhage into the cavity. Cutter and Gross are of the opinion that thoracoplasty has no place in the treatment of nontuberculous abscesses. The only time that artificial pneumothorax might be justified is when the abscess is centrally located and there is little chance of its rupturing into the pleural cavity. When a patient fails to improve under conservative treatment, surgical drainage should be employed. This should be by the two stage method unless the abscess is large with extensive pleural involvement or the patient is toxic and needs immediate relief.

**Bronchiectasis**—Surgery for bronchiectasis is much more promising than in pulmonary abscess. In such cases again the extent of involvement must be estimated accurately. Conservative treatment by bronchoscopic and postural drainage is beneficial and is the only procedure for extensive bilateral involvement. The removal of three bronchiectatic lobes has been found to be compatible with the patient's well being.

**Pulmonary Tuberculosis**—*Collapse therapy* the universally accepted surgical treatment for pulmonary tuberculosis



consists of phrenic nerve block, artificial pneumothorax, pneumoperitoneum, pneumonolysis and thoracoplasty. Only during the last decade has collapse therapy been given sufficient trial for an appraisal of its merits. The results have been gratifying. Each procedure has its place and limitations and each case should be individualized to determine the applicability of the various collapse procedures. This therapy when properly used will place the lung at rest, collapse and heal cavitation, make the patient afebrile and the sputum negative. If it does not accomplish these things, a revision of the collapse therapy must be made with the probability that a more extensive and permanent collapse will have to be done. May I also emphasize that thoracoplasty should be done carefully and in stages—not more than two or three ribs at one time being resected.

**Tumors**—The greatest stimulus to thoracic surgery has been the successful removal of one or more lobes of the lung, an entire lung and the removal of mediastinal tumors, all of which has been accomplished since 1931. The progress has been rapid and today all active thoracic surgery clinics operate in these cases. The increasing importance of these advances is evident when one realizes that from 7 to 10 per cent of all cancers originate in the bronchi. This rate of incidence is higher than is the rate for malignancy of the rectum and colon. Many authorities believe that the number of cases of cancer of the lung is increasing. When in addition consideration is given to the fact that a large percentage of the cases upon diagnosis are found to be inoperable, then it is realized that this condition warrants serious consideration.

When the diagnosis is made *early*, a cure can be obtained by means of surgery which is the only treatment to date offering any hope. Six years ago the mortality rate was 100 per cent while in 1940 Graham and Blades had a series of eleven consecutive total pneumonectomies with only three operative deaths, a mortality of 27 per cent. Overholt reports on fifty-eight collected cases of lung malignancy with a 65.5 per cent mortality rate and his own series of fifteen with a mortality of 33.3 per cent.

The author has performed five total pneumonectomies all for malignancy of the right lung. In the first case the tourniquet mass ligation was used. In this case in addition to the bronchogenic squamous cell carcinoma of the right stem bronchus bronchiectasis was present. The patient died from acute pericarditis empyema and bronchial fistula. Another patient lived seven months finally dying from extension of the process it being necessary at operation to peel the lesion from the first second and third ribs posteriorly. This was a so called sulcus or Pancoast tumor. The patient showed symptoms which indicated thoracic sympathetic involvement (Horner syndrome).

In one case while the lung was being manipulated during ligation difficulty was encountered in aspirating mucus from the contralateral bronchus. Before suction could be re-established respiration ceased the heart went into fibrillation and stopped. At this time the bronchus was cleared and oxygen was given intrabronchially. The heart was stroked with the finger. It started once more to fibrillate and then established its normal rhythm. The operation was completed and the patient returned to the ward in fairly good condition but died thirty six hours later. Nothing was found at autopsy to account for the death which was probably due to a mediastinal shift or to too much surgery at one time.

Another patient was progressing satisfactorily when on the sixth postoperative day he became restless and sodium amytal was prescribed. As often happens with this drug it acted as a stimulant instead of a depressant and the patient became hallucinated. He died suddenly while struggling with three men who were holding him in bed.

A patient referred to previously who had hypotension pneumothorax after pneumonectomy recovered and now three years after operation he is apparently cured. In only one case was the posterior approach used it was abandoned because it was found to be more formidable than the anterior intercostal procedure. Four thoracotomies were attempted on known malignancy.

nancies of the lung but in each case the condition was found to be inoperable with the mediastinum frozen.

The following is recommended in *pneumonectomy*: preoperative artificial pneumothorax, one stage procedure, anterior third intercostal space approach, avertin and local anesthesia, intratracheal aspiration and pressure control. Cyclopropane or gas ether can be used to augment the rectal anesthesia. Regardless of the type of anesthesia used, if the parietal pleura and hilar structures are blocked with local anesthesia there will be much less chance of shock. Drainage is inadvisable after lobectomy or pneumonectomy.

The outstanding accomplishments in thoracic surgery have been in the treatment of chest injuries, the improvement in the mortality rate for lobectomy and pneumonectomy, and the surgical removal of mediastinal tumor. There has been less advancement in the treatment for cancer of the thoracic esophagus and in the reduction of the high mortality rate in pulmonary abscess. The profession should become more lun cancer conscious.

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SURGICAL EMERGENCIES OF THE ABDOMEN

GOUVERNEUR V EMERSON M D F A C S

C MED C PS U TE S A EN AR Y C SU SERVI  
L ITERMA GENER HOS ITAL S FRA CISCO CALIFOR.

IN military practice owing chiefly to the grouping together of large numbers of young adult males who are in an age period in which certain diseases are more prevalent the rate of admission to hospitals for intra abdominal conditions requiring emergency surgery will be found to be higher than in a civilian community of a corresponding size Particularly is this true of appendicitis and particularly does the problem presented by appendicitis vary from that presented by routine admissions for conditions requiring surgery that is definitely elective in nature Before an emergency operation is performed there are two essentials to provide for—first accurate diagnosis and econd the prompt arrangement or preparation for the operation—and with these factors in mind the Surgical Service of an Army hospital is so arranged by the detail of qualified technicians from all surgical sections and from the laboratory and roentgenologic department that diagnostic procedures are immediately available day or night

This arrangement provides the means for an accurate diagnosis adequate preparation of the patient for surgery and the prompt performance of the emergency operation

Close contact is made with the Medical Service for emergency consultation to rule out conditions distinctly medical which may simulate a surgical emergency (pneumonia and coronary thrombosis) and to secure advice in the preparation for

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operation in those cases presenting grave complications and frequently requiring emergency surgery.

Appendicitis the surgical complications of peptic ulcer in testinal obstruction and acute cholecystitis are the most frequent conditions of the abdomen requiring emergency operations so in the main most of the problems are clear and easily settled. Occasionally by reason of age weakened condition of the patient or attending complications the skill judgment and ability of the most experienced surgeon will be taxed in the management of these emergencies.

### APPENDICITIS

Appendicitis is the most frequent intra abdominal pathological condition requiring emergency surgery in military as well as civilian hospital and as the strength of the Army increases so will the number of men needing emergency operations. So much has appeared about appendicitis in the literature of recent years from the pens of surgeons of great renown that it seems that there is little left to say about this condition yet it continues to take its toll of lives. Improvement in surgical technique together with recent advances in diagnostic adjuncts have not improved the statistics.

**The Urgency of Operation**—Appendicitis while not a preventable disease is one that in the main is relatively easy to diagnose and one that lends itself to cure by a classical procedure if action is taken in time. I do not believe that the mortality depends on a particular type of incision a particular method of handling the stump or a particular postoperative regimen but rather upon an early diagnosis and an early operation. Axioms have no place in teaching or in practice when appendicitis is dealt with though they may be a valuable aid to their originator they are a distinct hazard when followed by the many and they should not be offered as means of differential diagnosis or as cocksure rules. Delay is the greatest single factor contributing to the mortality of appendicitis and no matter where the responsibility for it rests the final result is the same—an advanced state of the disease complications

and increased death rate. It must be insisted upon that the emergency in appendicitis is *early* rather than late and that *the operation must be performed as soon as the diagnosis is made* regardless of the time of day or night and irrespective of the surgeon's other impelling duties or engagements.

The only way that suppurative and gangrenous appendicitis can disappear from our classification of this disease is by the exertion of every effort to place these patients in the hands of a surgeon as soon as the early symptoms of appendicitis appear so that he can remove the appendix immediately after the diagnosis has been made.

**Mortality**—In the military service owing to the immediate availability of medical attention and provisions for hospitalization for all members of the service patients come under professional surveillance much earlier than in civilian practice. Because of these factors lower mortality rates are to be expected. Bliss<sup>1</sup> reported ten deaths in 2100 operations for acute appendicitis a mortality rate of 0.47 per cent. He concluded that early control of military patients was a factor in the achievement of this low mortality. Johnson reported four deaths in 1281 operations for appendicitis on the Surgical Service of a Naval Hospital and on a Hospital Ship of the Fleet. He is of the opinion that the provisions for early medical care and hospitalization in the Navy together with early operation were important factors in bringing about the low mortality.

In a series of 1254 operations performed on the service of the writer from January 1 1935 to June 1 1940 there were three deaths. These figures are representative of the statistics for the Army as a whole. During 1939 there were 2124 operations performed in the Army for appendicitis with eighteen deaths. In 1940 there were 1999 operations performed for appendicitis with thirteen deaths.

**Operative Technique**—Our emergency service is so arranged that all cases of abdominal pain suspected of being surgical are seen immediately by a member of the surgical staff and when appendicitis has been diagnosed immediate operation is performed. The McBurney incision is the method of choice in

all cases in which the diagnosis is clear-cut the right rectum incision being reserved for the obese individual and for those cases in which the diagnosis is in doubt and exploration will be required. The stump always is buried except in those cases in which the cecum is indurated by the inflammation when the free drop method is used after cauterization or carbolization. Spinal anesthesia is the anesthesia of choice. Attempt is made to remove the appendix in all cases but when it is found in an advanced state of inflammation pocketed in an abscess which has not become adherent to the abdominal wall a drain is placed at the site of the abscess and the appendix is removed at a later date.

#### ACUTE GALLBLADDER DISEASE

Many controversies still ensue among those of equal experience in the surgical treatment of the acute gallbladder the controversial points being the optimum of time for the performance of the operation and a definition of the so-called immediate or emergency period the early and the delayed periods. Although early operation is subscribed to the individual factors governing in each case should be the guiding influence in this decision.

In military hospitals acute cholecystitis is a fairly frequent cause of admission and its treatment cause the same degree of concern as in civilian institutions. These patients admitted to the hospital are primarily assigned to the Medical Service and close collaboration with the Surgical Service maintained to determine the best time for surgical intervention in a given case. In most instances these patients come under observation soon after the onset of the disease and this early hospitalization is a favorable influence on the outcome of the disease.

**Immediate Versus Delayed Operation.**—Generally speaking the term emergency is reserved for those few cases in which it is apparent that the disease is rapidly progressing and perforation seems imminent. This period presupposes operation within an hour or two following admission. The problem then is to determine the *type of operation* best suited to the case.

and in making this important decision one must be guided by the condition of the patient and the degree of inflammation present together with the complications encountered

In the surgical treatment of acute gallbladder disease a definite policy that is suited to all the cases cannot be established as can be done for instance in the management of acute appendicitis though the similarity of the inflammatory process has frequently been the basis of argument for the same type of surgical management. The two conditions differ considerably in the liberty that may be taken in the delay of the surgical intervention

Few gallbladder conditions with the exception of the perforations due to ulceration or suppuration demand emergency operation. In those cases that do the speed of surgical intervention is as important as in any other intra abdominal catastrophe amenable to surgical treatment. Most of the gallbladder conditions will benefit by a period of observation ranging from several hours to several days during which time the body fluids can be restored and preoperative preparation instituted while a safe estimate is made of the surgical requirements. This procedure puts most of the cases in the so called early group for surgical interference

In the military service (due to the rigid examinations on entrance and periodic examinations while on active duty) the complicating diseases that would influence management of surgical emergencies are undoubtedly less than in civil practice and the patients are in an age group and in physical condition better able to endure the seriousness of the required surgical procedure

**Choice of Operation**—*Cholecystectomy* is certainly the operation of choice if it can be performed with assurance that grave damage will not be done to important neighboring structures which may have become edematous friable and indurated from extension of the inflammation. Whether this procedure is accomplished from the cystic duct up or from the fundus down should depend on the findings at operation. The latter procedure is considered much safer when the gallbladder is dis-



tended and friable and when the degree of inflammation makes the isolation of the cystic duct difficult. In those cases in which observation reveals that the process has subsided operation can best be performed when inflammation and edema have subsided. In all cases drainage of the gallbladder bed by means of a stuffed Penrose drain is recommended.

*Partial cholecystectomy* may have to be resorted to in some instances of advanced disease.

There will always be patients weakened by prolonged illness, dehydrated by fluid loss or jeopardized by complications whose best interests will be served by *cholecystostomy* even though secondary cholecystectomy will have to be performed at a later date. Cholecystostomy will suffice in approximately 80 per cent of the cases. Secondary operation will be required in the remaining 20 per cent.

Surgery in the jaundiced patient is not attempted until suitable therapy with vitamin K and bile salts has restored the prothrombin level to the limits of safety.

### Case Report

A white male forty-one years old was admitted to the hospital June 8, 1941 at 7:00 A.M. with the chief complaint of severe general abdominal cramps existing since 10:00 P.M. the night before. His temperature was 99° F., respirations 24, pulse 88, face flushed and dry.

*History*—The patient's history revealed that the week previously he had been treated at another hospital for severe abdominal pain which lasted for twelve hours. He was admitted to the hospital for several days after pain subsided and upon discharge from the hospital he was given laxatives and a diet. Following indiscretions in food and drink the patient was seized with attacks of severe vomiting at about 8:00 P.M. and during the course of one of the vomiting attacks at 10:00 P.M. he experienced a sudden severe pain in the epigastrium which later became generalized and spread up the patient. He had had no previous pain of this type. He was very nervous and anxious and had a feeling of impending doom. He had no previous history of gallbladder disease or other abdominal disorders.

*Laboratory Data*—The patient's blood count on admission was: erythrocytes 4,500,000; leukocytes 21,800; hemoglobin 90 per cent; polymorphonuclear leukocytes 87 per cent; lymphocytes 11 per cent; monocytes 2 per cent. Urinary examination was essentially negative. Roentgen examination of the abdomen showed no abnormality.

phr gm and pleura to be essentially normal. A flat plate of the abdomen was of no diagnostic significance. The provisional diagnosis was ruptured peptic ulcer.

*Exploratory Operation*—The abdomen was opened through an upper right rectus incision. There was approximately 500 cc of bile colored fluid in the peritoneal cavity and considerable infiltration of the lesser omentum with bile. The omentum was slightly adherent in the region of the gallbladder by fresh fibrous adhesions. These were freed and the gallbladder was found to be markedly acute and moderately thickened. There were no stones palpable. The gallbladder was somewhat distended. After the adhesions were freed the cavity was explored through the foramen of Winslow. Results were negative. Duodenum and stomach were found to be normal and showed no evidence of ulceration or perforation. It was concluded that the presence of bile in the peritoneal cavity was due to a spontaneous rupture of the gallbladder in the vicinity of the cystic duct or probably in the duct itself.

*Cholecystostomy and Results*—A No. 18 catheter was placed in the gallbladder and cholecystostomy was completed. The postoperative course was entirely satisfactory. Operative findings: ruptured gallbladder with bile peritonitis generalized. Operation: cholecystostomy. Result: recovery.

### ACUTE INTESTINAL OBSTRUCTION

**Conditions Producing Obstruction**—A wide variety of pathological conditions may be the causal factors in this acute intra-abdominal catastrophe which is encountered with sufficient frequency in military hospitals to justify its classification among the serious surgical emergencies. Chief of the causal factors are external hernia, internal hernia, obstruction due to adhesions and bands, volvulus, intussusception, and acute obstruction due to malignant lesions of the lower bowel.

*Strangulated Hernia*—Though a frequent cause of obstruction in civilian practice, especially among patients in the extremes of the life span, strangulated hernia is much less frequently seen in military practice owing chiefly to frequent rigid physical examinations and the service requirement of operation as soon as a hernia is discovered, the condition untreated being classified as an incapacitating defect. The percentage of refusals of patients to submit to operation therefore is small and we are spared the necessity of educating

tended and friable and when the degree of inflammation makes the isolation of the cystic duct difficult. In those cases in which observation reveals that the process has subsided operation can best be performed when inflammation and edema have subsided. In all cases drainage of the gallbladder bed by means of a stuffed Penrose drain is recommended.

*Partial cholecystectomy* may have to be resorted to in some instances of advanced disease.

There will always be patients weakened by prolonged illness, dehydrated by fluid loss or jeopardized by complications whose best interests will be served by *cholecystostomy*, even though secondary cholecystectomy will have to be performed at a later date. Cholecystostomy will suffice in approximately 80 per cent of the cases. Secondary operation will be required in the remaining 20 per cent.

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*History*—The patient's history revealed that one week previously he had been treated at the other hospital for severe abdominal pain which lasted for twelve hours. He was admitted to the hospital for several days, felt pain disappeared and upon discharge from the hospital he was given leave and came to this city. Following indiscretions in food and drink the patient was seized with attacks of severe vomiting at about 8:00 P.M. and during the course of one of the vomiting attacks at 10:00 P.M. he became dizzy and doubled up. The patient had no previous pain that would in any way implicate that of a peptic ulcer.

*Laboratory and X-ray Data*—The patient's blood count on admission was: erythrocytes 4,500,000; leukocytes 21,800; hemoglobin 90 per cent; polymorphonuclears 87 per cent; lymphocytes 11 per cent; monocytes 2 per cent. Urinary was essentially negative. X-ray examination of the chest showed the heart lungs dia-

Accuracy of diagnosis is nowhere more important than in this type of case the management of which should be entrusted only to those most experienced in the differentiation and evaluation of the complicity of the manifestations. Failure to recognize the strangulating types of obstruction in which permanent damage has been done to the vascular distribution of the entrapped loop may spell failure for conservative measures instituted in the belief that operation might have been avoided. The operative findings in cases of this type are interesting and diversified. They range from simple band or rope adhesions and omental deflections angulating or constricting the bowel to massive adhesions between loops that interrupt intestinal continuity.

**Ictulus**—Volvulus of the small intestine is encountered very infrequently and it may vary in extent from the inclusion of a small loop to a massive process involving many feet of the bowel. Here again the speed with which the condition is recognized and surgery is instituted spell life or death for the loop involved and success or failure of the procedure to avert a fatality.

**Intussusception**—Owing to the fact that intussusception occurs chiefly in infancy and childhood it is not an important factor among the admissions for hospitalization in military practice.

**Obstruction in the Large Bowel Due to Malignancy**—Acute occlusion of the bowel by a malignant growth in the splenic region of the colon or in the sigmoid is occasionally the cause of an emergency admission at a time when late distention characteristic of lower bowel obstruction demands emergency decompression. It is important in cases of this kind to make a preoperative differentiation between small and large bowel obstruction. A flat x ray plate of the abdomen is frequently of value in this determination.

**Treatment**—It is nowhere more important to make an early and accurate diagnosis than in cases of intestinal obstruction for it is on *successful diagnosis* that successful treatment depend. In cases of this kind we must decide between the

patients in the care of hernias the method of reduction and symptoms of strangulation. Most patients present themselves for treatment as soon as the defect is discovered. When strangulation does occur the case comes under medical observation promptly which means early hospitalization and early operation. Thus devitalized loops are rarely encountered.

*Obstruction Due to Adhesions and Bands*—Adhesions of one type or another are a frequent cause of interruption in the con-



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pc sca

tinuity of the bowel and recently with the great increase in the strength of the Army and the corresponding increase in the number of those who have had previous surgical obstruction from this source is a much more frequent cause for admission to the hospital. Attention we believe should always be focused on the scar and an accurate history pertinent to the primary operation should be obtained from patients who present symptoms suggesting obstruction.

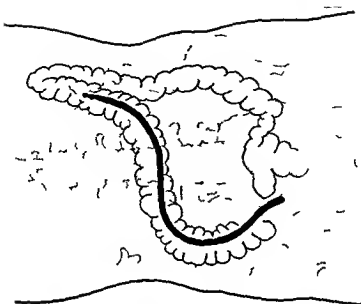
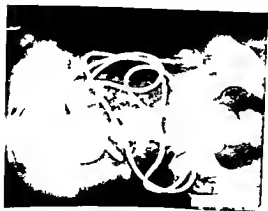
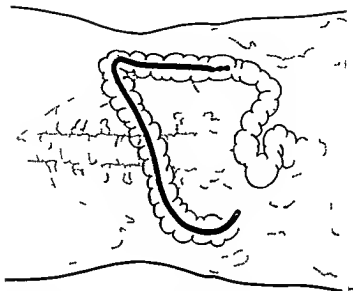


Fig 351

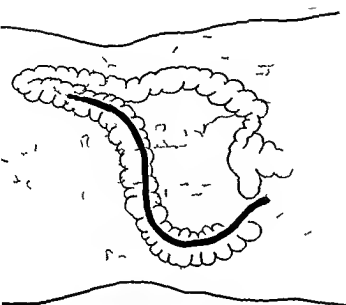
Miller Abbott tube in  
transverse colon

pend the type of treatment—conservative or operative. As mortality is in direct proportion to the time intervening between the onset of the symptoms and the institution of treat-



Miller Abbott tube in  
proximal sigmoid

institution of the newer methods of sphincter suction the use of a two-way drainage tube or immediate surgical intervention for on the degree of obstruction and the type of obstruction de



F 351

Miller Abbott tube in  
transverse colon

pend the type of treatment—conservative or operative. As mortality is in direct proportion to the time intervening between the onset of the symptoms and the institution of treat-



ment it must be realized that any procedure that lengthens the interval will contribute to an unfavorable outcome. High mortality in obstruction as in appendicitis and perforation is attributable directly to delay.

*Decompression*—The introduction of continuous suction by Wangensteen and the advent of the two way tube of the Miller Abbott type have provided valuable additions to the conservative management of certain types of obstruction particularly of that due to ileus the mortality of which has been greatly reduced by the timely introduction of these method of decompression. Attention here must be directed to the importance of differentiating an acute mechanical obstruction from a simple or incomplete type and likewise from an adynamic ileus for even the most ardent advocates of tube decompression caution against its use in a suspected or known case of strangulation. Failure to make such a differentiation or to use the tube decompression as a preliminary to surgery in the mechanical types of obstruction will prolong the period of delay and will contribute materially to a high mortality. The two way tube can be passed great distances and it often decompress distended loops as it proceeds in its course and catenae and releasing points of incomplete obstruction. Occasionally in large distentions due to constriction near the ileocecal valve the tube may fail to deflate as completely as may be desired. We have passed a Miller Abbott tube into the cecum transverse colon and descending colon on several occasions.

*Fluids*—Important in the treatment of obstruction is the replacement of fluids lost by vomiting or by aspiration in the patients who have had decompression. Toxemia should be combated by an adequate amount of fluid in the nature of normal saline with 5 or 10 per cent glucose. To meet the chloride loss hypertonic salt solutions should be used particularly in cases of high obstruction in which the vomiting has been severe. No matter what the type of obstruction is the fluid requirements in the individual case should be met by intravenous administration. Transfusion may be decided a factor in the outcome of any case.

*Surgey*.—Immediate surgery of the simplest type consistent with the condition of the patient is advocated in all cases of complete occlusion of the lumen of the bowel. Release of constricting bands of adhesions in certain cases will alone suffice. Primary resection is advocated in all cases in which the viability of the bowel has been lost and in which the condition of the patient would justify the attempt. In those cases in which the condition of the patient is grave and the viability of the bowel has been lost exteriorization of the gangrenous bowel with provision for enterostomy should be performed in the most expeditious manner. In strangulated hernias the obstruction should be released and the contents of the sac thoroughly observed to determine the viability before the sac is returned to the abdomen. Following the release of the obstruction repair of the hernia by the modified Bassini method should be performed.

The mortality in complete mechanical obstruction as before stated is in direct proportion to the time intervening between the onset of the symptoms and the surgical intervention. The degree of obstruction and the condition of the patient should dictate the operative procedure. It should be kept in mind that prolonged and complicated procedures contribute materially to mortality in those cases in which temporary procedure of the simplest type may be the life saving factor.

### Case Reports

I. A young man was admitted for left inguinal complete strangulated hernia which occurred at a camp sixty miles distant from the hospital. The patient had noticed a mass in the left groin for several weeks and had made no previous report of his condition. Onset of symptoms began after a slight effort while lifting. Colicky pains, nausea and vomiting ensued and the efforts of the patient failed to relieve the mass. He reported for treatment and was transferred to the hospital where immediate surgery was decided upon. Spinal anesthesia was used and while the abdomen was being draped the mass spontaneously reduced. The operation was proceeded with and the sac was opened. A considerable amount of serosanguineous fluid was encountered. Investigation was made of the former contents of the sac and a 9 inch gangrenous section of the jejunum

was encountered. As the patient was in good condition primary resection was performed following which the hernia was repaired. Recovery was uneventful.

II. A white man, aged sixty years, who was admitted for the treatment of arthritis developed sudden severe colicky pain, nausea and vomiting at 1:00 A.M. and made no report for several hours. When examined by the officer of the day classical signs of acute mechanical obstruction of the intestine were apparent. There was a mild degree of shock. Exploration of the abdomen revealed volvulus of the jejunum with 18 inches of devitalized intestine. Primary resection was performed. Convalescence was uneventful until the tenth day when he began to have nausea and to vomit. Blood was positive for malarial parasites. Quinine therapy was instituted with the abatement of all symptoms and the patient recovered promptly.



Fig. 352—Distal ileal perforation of the ileum. M.H. Abbott. Case of ileal perforation. Operation. R. 3. Sed. H. T. B. M.

III. A man aged twenty years was admitted to the hospital March 1, 1941 with the diagnosis of butyral fever.

adhesions following operation performed in 1929 prior to entry into military service. His chief complaint was abdominal pain and vomiting of one day's duration. His history revealed that at the age of twelve he had an operation for appendicitis through a McBurney incision. Since that time he has had repeated attacks of abdominal pain with vomiting on an average of two to three times a year. The present attack resembled the former ones except that it was considerably more severe. The remaining history was not nonessential. Physical examination revealed a moderately distended abdomen with no particular tenderness. Examination of the heart and lungs was essentially negative. A Miller Abbott tube was passed under fluoroscopic visualization (Fig. 352) and a satisfactory decompression was effected. The tube reached the point of obstruction on the third day after which it passed into the cecum and down to the sigmoid colon. Following decompression by this means an exploratory laparotomy was done on March 5 at which time other extensive adhesions angulating the ileum to the old scar were found to be the cause of the obstruction. These adhesions were freed and the patient's subsequent postoperative course was uneventful. He was returned to duty in the usual time.

### PEPTIC ULCER

The complications of peptic ulcer whether it be situated on the duodenum or on the stomach are the most serious and most dramatic of the acute abdominal emergencies.

**Hemorrhage**—Bleeding of varying degree probably is the most frequent complication of peptic ulcer. It may be a difficult problem to determine the source of a massive hemorrhage in an individual who is admitted to the hospital with no previous history of ulcer. Occasionally the emergency arises in patients already in the hospital and under treatment for ulcer, the incidence of the complication in duodenal ulcer being approximately 18 to 20 per cent.

When a diagnosis of massive hemorrhage from ulcer has been determined the therapeutic procedure to be followed must be decided upon immediately. While fatalities from the first hemorrhage do occur, most patients survive it and the condition yields to medical management. Patients with repeated small hemorrhages or recurrent massive hemorrhages should be subjected to surgery at the optimum time. It has been our policy to operate after the second hemorrhage.

The operative attack upon the ulcer should be direct and should include some type of resection. In patients whose condition is too serious to justify the time consumed in resection, favorable results have been obtained by the Devine type of pyloric exclusion, the distal segment being split until the ulcer is exposed and then the vessel leading to its base are ligated. Gastro-enterostomy alone has no place in the treatment of hemorrhage from duodenal ulcer.

**Acute Perforation**—Both in the case of a patient with known history of an ulcer and in the case of a patient who has had no previous indications of digestive distress, the sudden onset of excruciating pain, initial collapse and boardlike rigidity of the abdomen are almost classical manifestations of acute perforation, a complication of an ulcer. Lest this condition be confused with an acute coronary episode, electrocardiography and roentgenologic examination of the abdomen for free air beneath the diaphragm are advised as preoperative diagnostic procedures.

Treatment of this condition is emergency in every sense of the word. The mortality is in direct proportion to the time that elapses between the perforation and the operation and is exceedingly low if operation is carried out in the first six hours.

It is usual in military hospitals to receive a patient of this kind soon after the onset of symptom, since medical diagnosis and transportation to a hospital are immediately available. The type of operation performed is simple closure of the perforation by mattress suture and the attachment of an omental ta-

Subsequent to recovery from an acute perforation, an ulcer regimen is maintained. At a later date, for those patients whose symptoms persist, direct surgical attack on the ulcer by some type of partial resection is indicated.

**Postoperative Care**—Intermittent suction by the Levine tube with a syringe is employed, since an indwelling tube with continuous suction is considered a hazard in an indurated and friable ulcer bed which has been repaired. Fluid balance is maintained by intravenous administration of glucose 5 per

cent and saline Sulfathiazole or sulfanilamide is used in those cases in which peritoneal soiling is great

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# TREATMENT OF CRANIAL INJURIES IN WAR

FRANCIS C GRANT M D F A C S

P E S N S I I M E D C I N U N I V E R S I T Y P E N N S Y L V A N I A

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THE present day treatment of war wounds of the head depends upon many factors. General surgical principles for their treatment were established during the final year of the war of 1914-1918 but new developments especially with regard to antiseptics and anesthesia have appeared which may modify these principles. Two lessons from World War I seem to stand out with regard to head wounds first that in cases of cranial trauma the patients can be transported with greater safety *before operation* than immediately thereafter and second the results in operative treatment of these cases are better when *spec ally trained men in properly equipped centers* handle them than when such cases are assigned to the general surgeon.

## REQUIREMENTS OF A NEUROSURGICAL CENTER

The staffing and equipment of the neurosurgical centers will determine the success or failure of the surgery performed. Adequate electric power is the first essential. For one thing it is necessary for the operation of roentgen ray apparatus. Again the two important technical advances in neurosurgery in recent years namely the introduction of suction and electro-surgery depend upon it. An electromagnet for the removal of deep seated steel fragments from the brain proved its value in 1917-1918. Heller states that the Germans have established special centers equipped with giant magnets to remove fragments from brain or eye. The power plant is therefore vital and should be of sufficient size to handle easily all such station requirements.





the more extensively the brain has been injured and the more widely the cerebrospinal fluid spaces have been opened the higher the death rate. Certainly the treatment of injuries of types III to VIII (there is little treatment available for class IV) is fundamentally the same in its general principles. The degree to which the underlying brain is damaged, the difficulties attending the debridement of the brain wounds and the removal of foreign material, the time interval elapsing between injury and operation and the amount of infection already present are the factors that will determine how such wounds should be handled.

#### MANAGEMENT OF CRANIAL INJURIES IN WORLD WAR I

In his capacity as senior consulting neurosurgeon to the American Expeditionary Forces in 1918 Dr Cushing issued suggestions to the neurosurgical teams which demand repetition. Every scalp wound, no matter how trifling, is a potential penetrating wound of the skull. Many penetrating wounds are met with even among the walking wounded. Only after an x-ray, after shaving the head and possibly only after exploration, can one be assured that there is or is not a cranial fracture with or without dural penetration.

If a case is operated upon and a penetration found, the operation must be completed with a primary closure following the special debridement applicable to these injuries. In this respect wounds of the nervous system differ from other wounds which in times of rush should not be subjected to primary wound closure. All or nothing is a good rule to apply to cranio cerebral injuries—in short, evacuate these cases untreated to the nearest base (except for shaving and the application of a wet antiseptic dressing) rather than do incomplete operations. Patients with cranio cerebral injuries stand transportation well before operation, badly during the first few days after operation. This is true of all primary wound closures.

Cranial cases in more or less shock (on arrival at the base) need not undergo a period of resuscitation. The operation should be done under local anesthesia combined with morphine.

Cutler has stated recently that the efficiency of any hospital depend largely upon the following factors: adequate electric power, proper sterilizers and a good laundry. It is to be hoped that in the rush for planes, tanks, ships and guns our Army Medical Corps will see to it that their basic needs are supplied. The Royal Army Medical Corps developed and sent to France an adequately equipped mobile neurosurgical unit. The plans together with any improvements shown necessary under service conditions should be available. Some similar arrangements will be essential if head wounds are to receive adequate treatment.

### CLASSIFICATION OF HEAD WOUNDS

After the last war the United States Medical Corps publications divided head injuries into nine groups upon the basis of their severity as gauged by the mortality rates.

	Mortality Percentage
I Wounds of the scalp	about 10
II Cranial fracture without dural penetration	about 10
III Contusion with depression and dural penetration but without serious brain injury	about 20
IV Wounds (usually of gutter type) with brain tissue and dura lacerated but without fatal brain injury	about 30
V Wounds usually of penetrating type with dural laceration and brain injury	about 40
VI Wounds of type IV and V with penetration of bone and dura but without fatal brain injury	about 50
VII Cranial wounds which threaten the brain but do not penetrate the dura	about 60
VIII Penetrating wounds with fatal brain injury	about 70
IX Extremely severe wounds with fatal brain injury	about 80

This classification of head injuries is all inclusive and seems somewhat cumbersome. In any cranial injury the outcome depends in great part upon two factors: first, the degree to which the brain itself has been damaged, and second, whether or not the dura has been opened. As the figures in the table indicate

may shift many miles in a week. The U S Army Medical Corps is prepared to meet the old conditions. It is essential that every effort be made to adapt the organization to as ure prompt and effective transportation of wounded under the demands of a rapidly changing battle front. *Mobile units* that are staffed and equipped to handle specific types of wound such as those of the head and thorax and that move with the fighting lines may well be an answer to this problem. Permanent hospitals may be too far to the rear to make transportation easy.

Ducun<sup>o</sup> in a paper based on his experiences in the Spanish Civil War gives a vivid description of the head wounds he encountered. The scalp wounds are never clean cut, the skin being usually widely contused in more than one area. The fracture is always comminuted with fissures extending toward the vault or base. The inner table is always more severely damaged than the outer with large fragments detached from it even though the outer table may not seem to be badly fractured. The dura is torn and contused. The brain substance beneath the injury or along the perforating tract is reduced to a pulp in which are often lodged hair, bone fragments, clothing or shell splinters. The ventricles have frequently been penetrated. The wounds are often of the through and through type and are associated with more destruction of bone at the point of exit than at the point of entrance. The wounds are frequently multiple especially from machine gun bursts are always septic and are not infrequently accompanied by additional wounds of extremities, thorax or abdomen.

#### TREATMENT OF HEAD WOUNDS AT THE REGIMENTAL FIRST AID STATION, THE DIVISIONAL CLEARING STATION AND THE BASE HOSPITAL

When such wounds are seen at the *regimental first aid station* nothing should be done except to shave the head about the wound, paint the skin with an antiseptic and apply a sterile dressing. No attempt whatever should be made to clean the wound itself. A *field card* should be made out for the patient. It should state the type and location of his wound and its

Consequently the patient can be properly warmed and given fluids during the course of the operation through which he will often sleep. Only in exceptional cases when the patients are irrational or uncooperative is a general anesthetic necessary. Its administration always adds to the difficulty of the operation and by increasing intracranial pressure causes extrusion of brain and tends to increase the damage already done.

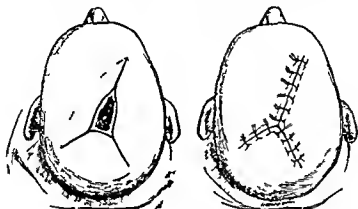
The chief source of the high mortality in cranial wounds is infection—i.e., infection of the meninges, direct infection of the brain leading to encephalitis, infection of the ventricles. Wounds in which the dura has been penetrated are supposed to give a mortality of 50 to 60 per cent due to infection. It has however been shown that experienced neurological surgeons can lower this supposedly inevitable mortality to 25 per cent if the operation can be done with reasonable promptitude in a forward area and the cases retained for a reasonable time after operation. These figures are capable of still further improvement.

#### PRESENT DAY PROBLEMS IN MANAGEMENT

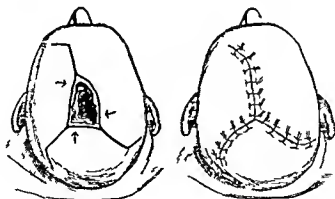
The wound of this war will differ but little from those seen in 1914-1918. Cairns and Volker have noted a tendency for them to be produced by smaller metallic fragments than formerly. The explosives now used are of greater bursting power and throw off less bulky splinters at a higher velocity. Multiple wounds are more frequent (Broster). But the principles of treatment are the same now as they were in the first World War. It is true that it is better to administer tetanus toxoid than antitetanus serum after injury and that there has been an improvement in the sera to prevent gas bacillus infection. The development of the sulfa derivative opens up tremendous possibilities in the prevention of infection.

In the last analysis however the problem is still the same, namely proper organization, needed to a speedy evacuation of the wounded to effectively staffed and equipped hospitals. The problem seems vastly different now than in 1918 when the fighting fronts were fixed for long periods, now they

reliance upon the efficacy of the drug seemed to be the chief trouble. The close application of the powder to all parts of



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the wound is difficult. The e men su suggest the incorporation of the sulfanilamide in a valine base so that it can be used in

cause (machine gun bullet bomb splinter etc.) A brief description of the patient's condition together with instructions for his evacuation in a sitting or in a recumbent position should also be given.

When the patients reach the *divisional casualty clearing station* the dressings are revised. At this point the examination of the wounded is more detailed and an attempt is made to reach a definite opinion as to their proper disposition. Patients with obviously hopeless injuries are retained and given morphine if they are not unconscious. Those with rapid and irregular pulse with bilateral complete pupillary relaxation with loss of sphincter control or pasticity of all four extremities do not warrant evacuation. All wounded should be given anti gas bacillus serum injections and 2 to 4 gm. of sulfanilamide by mouth or under the skin. Rapid evacuation is indicated for cases with evidence of extradural bleeding. The field cards of the wounded should state the urgency of their condition and whether there is a need for immediate operation. Patients with gutter wounds with penetrating wound whether partial or complete or with multiple injuries should be transported later. They should always be lying down when moved from place to place.

The question of the administration of blood or other *stimulants* to these patients requires no judgment. General experience seems to indicate that such measures may increase intracranial bleeding. Hypertonic solutions such as 50 per cent glucose or 10 per cent saline seem of more value than blood or stimulants as they have a dehydrating action on the brain and help a little to relieve shock.

Should *Isa-L* be used to *hydrate* in *and* when the *desing* are *rel* at the *d* *c* al *t* ition. Mitchell Logan and Haldy reached the conclusion based on their experience in the British campaign in Libya that *nuh* had still to be learned about the local application of *sulfanilamide* to make it really effective. The liberal use of the *du* locally certainly did not neutralize neglect of the *cardinal* points in the treatment of war wounds. In *un* *int* *la* *age* *d* *e* to a too great

erative difficulties. An intratracheal tube insures a free airway and in desperate cases permits the better administration of oxygen. As Cushing describes patients in shock can be revived by heat and fluid given intravenously during the operative procedure and the proper sulfa derivative given at the same time.

The scalp is thoroughly cleansed and the wound examined. Debridement of the skin edges is done and the knife and forceps discarded. Enlargement of the skin wound is best accomplished by the tripod incision or if more room is needed by the Isle of Man incision (Figs 353 and 354). The fracture is not treated by removing with a rongeur the dirty edges of the wound until a clean area is reached; instead trephines are placed just lateral to the edges of the wound, a space is cut between the trephines with Montanov's or De Vibrisse forceps or a Gigli saw and then the fractured portion is lifted out in one block (Fig 355). The dura is now inspected. It should not be opened unless a definite indication exists. If the membrane is tense and purple obviously overlying a blood clot or contused brain it should be incised, the underlying blood and contused brain sucked out and then the dura carefully closed with interrupted sutures of fine silk on small round needles without cutting edges. The galea and skin are now tightly closed with interrupted silk sutures without drainage or at most a rubber drain is placed in a dependent angle of the wound.

#### THE TREATMENT OF PENETRATING WOUNDS OF THE BRAIN

As can be seen by reference to the classification giving the types of head injuries a penetrating injury can be of any variety. Once the dura has been pierced and fragments of bone or metal have entered the brain the general principles of treatment are the same regardless of the size and depth of the wound.

**Conservative versus Radical Methods**—Cairns recently has stated: "Brain tissue resists and localizes bacterial infection as well as if not better than other tissues. It is the ven-



the way in which bismuth iodoform paraffin paste (bipp) was employed in the last war. They recommend highly its immediate and continued administration by mouth.

On arrival at the *base hospital* the wounded are reexamined and the urgent cases are selected for operation. In the last war

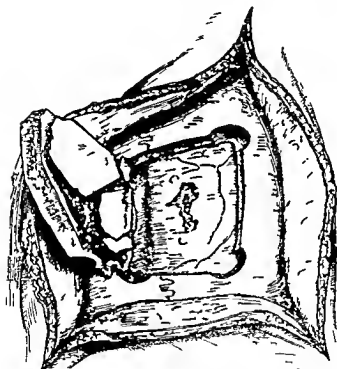


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19. 7. V. I. V. I. S. r. y. p. t. I. p. 8.)

local anesthesia ether and chloroform were the anesthetics available. Local anesthesia administered with morphine is best but veronal and pentothal sodium are alternatives. Pulmonary anesthesia should not be used if it can be avoided since it tends to raise intracranial pressure and thus increase the op-

erative difficulties. An intratracheal tube insures a free airway and in desperate cases permits the better administration of oxygen. As Cushing describes patients in shock can be revived by heat and fluids given intravenously during the operative procedure and the proper sulfa derivative given at the same time.

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**Conservative versus Radical Methods**—Cairns recently has stated: "Brain tissue resists and localizes bacterial infection as well as if not better than other tissues. It is the ven-

tricular cavities and large basal cisterns that are so vulnerable to the spread of infection. In brain wounds as in wounds of the limb it is desirable to remove necrotic tissue, bone splinters and foreign bodies with the object of preventing or restricting the spread of infection in the form of purulent encephalitis, abscess, purulent ventriculitis and meningitis. The aim is to obtain a clean, smooth-walled cavity which with the aid of light packing will heal by granulation. This is the ideal but there are weighty limiting factors. The operation must be done without encroaching on important nervous pathways that are known to be intact and without opening the intracranial cavities or basal cisterns. Preparations for treatment therefore include thorough clinical examination and radiographic survey of the foreign bodies. Missiles deep in the brain should usually be left alone and superficial wound over such important areas as the pre- and post-central gyri should be interfered with as little as possible.

How is the balance to be struck between conservative method so essential in some cases and the bold operation so necessary in other cases if fatal infection is to be prevented? Inadequacy of surgical facilities will in some instances decide the question for the time being but in most doubtful cases the only sure guide to treatment is the clinical state of the patient observed from day to day. In a patient with a deep penetrating wound of the brain with small aperture intervention may at first be postponed until the physical signs or increase of protein in the cerebrospinal fluid indicate that the brain lesion is extending instead of healing. In large open wounds of the brain the removal of necrotic tissue is easy if suction apparatus is available. This apparatus is essential in all brain operations. After careful hemostasis the wound is lightly packed and the condition of the resulting bacterial fungus is subsequently controlled by lumbar punctures at frequent intervals.

**Exposure and Cleansing of Wound**—The general principles to be observed in the treatment of these wounds of the brain are as follows. An adequate skin opening is centered on the surface wound made by an Isle of Man needle. The

skin edges of the penetrating wound should be carefully excised. The fragmented portion of the skull is removed by trephining and cutting around it then it is lifted out in one piece. If the wound is of the gutter type near the sinus a spicule of bone may have been driven into the sinus. Its removal will be followed by furious bleeding. Such hemorrhage is best treated with a stamp graft of muscle held over the bleeding point by the finger for a minute or two and when the bleeding is checked maintained in position by a suture.

The opening in the dura should not be enlarged nor the adhesions between it and the underlying brain broken up but all fragments of dura must be excised. The patient is now asked to cough or strain or if he is under an anesthetic the anesthetic increases the intracranial pressure by jugular compression in the neck thus forcing out clots and other debris. Further cleansing of the wound is accomplished by irrigation with saline solution and finally the tract is carefully cleared of all contused brain with the suction apparatus until a smooth walled cavity has replaced the ragged tract. All foreign bodies are of course searched for and removed unless they are small and very deeply indriven. Especially if metallic such fragments are best left alone.

**Closure of Dura and Skin**—The problem now comes up as to the closure of the dura and the skin. Cushing who worked in a casualty clearing station near the front where the patients were seen usually within forty eight hours after being wounded gives it as his opinion that skin closure without drainage is indicated whenever possible. Horrax<sup>1</sup> who worked farther behind the lines in a Base Hospital where the wounded were seen from four to six days after injury with consequently much more widespread infection expressed the belief that the skin should not be closed. He prefers to leave the skin flaps open to obtain better drainage accept fungus formation as a favorable complication and control its formation by repeated lumbar tap. But as a rule primary closure of galea and skin in separate layers with interrupted silk sutures is indicated.

It is in this group of cases certainly that the *sulfa-deri*

*altis* may revolutionize method and results. Faloner and Russell<sup>7</sup> and Manifold<sup>8</sup> have shown that sulfathiazole in isotonic and approximately neutral solution is relatively harmless to the brain. Certainly these solutions by mouth or subcutaneous administration should be able to control meningitic infection and in many cases make it possible for the surgeon to close a much higher percentage of wounds with healing by first intention without subsequent development of a brain abscess or encephalitis.

**Osteoplastic Flap Technique**—Burckhardt, Vincent and Lafon<sup>9</sup> and Garcin and Guillaume<sup>10</sup> have used the formal osteoplastic flap in the surgical approach to penetrating wound. As they state this usage is only possible in advanced zone neurosurgical hospital well staffed and with complete neurosurgical equipment. An osteoplastic flap is turned down around the penetrating wound. Ducum states that he attempted this technique but found that the fractures around most penetrating wounds were so extensive that the flap broke to pieces when it was being elevated. Vincent sutures the dura to the brain about the defect to produce adhesion and to wall off the subarachnoid space. Careful debridement of the tract now is instituted and finally the tract completely excised with fine scissors. The dural defect closed with a fascial graft or with amniotic membrane, the flap replaced, the galea and skin carefully sutured. Garcin and Guillaume especially emphasize the value of the sulfonamide derivative postoperatively.

This technique is certainly the ideal toward which the neurosurgeon should aim. With advanced mobile teams to whom the wounded can be sent within ten to twelve hours plus an opportunity to keep them under observation for the three weeks following operation many problems may be solved. But when the paper of Ducum is reviewed and compared with the others mentioned and distinct impression gained that the conditions he describes are more nearly the true picture. In the presence of a penetrating cranial wound that presents at least potential severe infection to turn down a flap and to close the dura tightly seems like flinching directly in the face of Providence.

**After care**—Following operation patients suffering from head injuries should not be evacuated for a minimum of three weeks. A nursing personnel familiar with the after care of such types of wound should be detailed to the neurosurgical hospitals.

The most dreaded *postoperative complications* are hemorrhage, brain edema and above all infection. The evidences of the development of such complications are often masked at their onset and experience is needed to interpret them. Unfortunately, when they become full blown, for any tyro to recognize it is too late to do much to combat them effectively.

Postoperatively, free sedation is to be preferred to strap restraint in restless patients. Straining against handcuffs increases intracranial pressure and encourages hemorrhage and intracranial edema. Pressure can be relieved by lumbar or ventricular taps. Fluids should be administered freely with blood or plasma as needed. The operating surgeon should, if circumstances permit, see to the after care of the wound of his own patients. He knows exactly what was done and has therefore the best idea of what complications to expect. Furthermore, although the neurosurgeon has learned much about what he can or cannot do in brain injuries in the last fifteen years, and although he has the sulfa compound to help him combat infection, he will find that war surgery presents new and perhaps difficult experiences. Mistakes will, of course, be made, but the men who see their patients most frequently will profit most quickly from their errors.

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that there was a lack of trained urological surgeons. Urological patients who were admitted to the department were later transferred to the Surgical Service for operative treatment.

**Training and Clinical Experience of Personnel**—In 1921 the Bureau of Medicine and Surgery instituted a system of training its medical officers by giving them special courses of instruction in urology in some of the larger clinics in the country, namely The Brady Urological Institute, Baltimore, Maryland; The University of California, San Francisco, California; The Brady Urological Institute, New York City; and the Post Graduate Medical School and Hospital, New York City. As a result, in the past twenty years a sufficient number of Naval medical officers have completed these courses to staff the Urological Departments in our hospitals.

The admission of Veterans Bureau patients to Naval hospitals was commenced in 1921, and these patients have probably contributed 80 to 85 per cent of surgical urology during this period of twenty years. For example, in the Naval Hospital at Philadelphia, out of a total of 800 patients, approximately 500 are Veterans Bureau patients, the majority of whom are in an age group in which a high percentage of surgical urology is to be expected.

The above two facts, namely the special training of Naval medical officers in civilian clinics and the vast amount of clinical material supplied by the Veterans Bureau, have been largely responsible for the development of urological work in the Service.

**Present-day Organization**—The Department of Urology is conducted as a separate department in most of our larger Naval hospitals, with its Chief of Service, who is responsible for his own surgery. Its organization is patterned after the general scheme of a civilian institution. In some Naval hospitals the Urological Department is included under the general Surgical Service, with the Eye, Ear, Nose and Throat, Physical Therapy and X-Ray Department for administrative purpose only. The Urological Department also includes Syphilology, and until very recently it also included diseases of the skin.

*Advantages in Shifting Syphilis to Department of Dermatology*—In one of our larger Naval hospitals syphilology and dermatology have just been placed in a combined Department of Dermatology and Syphilology. This arrangement appears particularly advantageous at this time and for the following reasons:

1 Cutaneous diseases represent a fairly large proportion of the total morbidity and until now have not received their merited specialistic attention.

2 Syphilis is combined with Dermatology in civilian practice and civilian institutions and all qualified dermatologists are also qualified syphilologists. At the present time the calling in of significant numbers of Reserve physicians insures the Medical Corps of adequate numbers of dermatosyphilologists while the urologists being called to active duty are not trained or experienced in syphilology.

3 The placing of syphilis in the Department of Dermatology puts it in a medical specialty and removes it from what is primarily a surgical service. It is universally acknowledged that the problems of syphilology encompass many aspects of general medicine.

4 Both the urologist and the dermatosyphilologist will be able to work with greater efficiency and the services to function at a higher degree of perfection in specialized treatment instruction and training when the lines demarcating the specialties within the military establishments are equivalent to those now generally accepted in all nonmilitary medical activities.

*Staff and Equipment of Hospitals*—Two urologists are assigned to our larger Naval hospitals provided the exigencies of the Service permit. The actual ward space assigned to urological surgery is usually approximately equal to that provided for syphilology and venereology. A completely equipped cystoscopic room is maintained and usually located in the immediate vicinity of the x-ray department. Two standard cystoscopic tables are provided with the necessary x-ray accessories. The supply table of the Medical Department U. S.

Navy lists a complete line of basic supplies and equipment which are available on requisition. Special items of equipment are available on approved special purchase requisitions and by placing such items on the advance budget.

### KIDNEY

**Acute Infection—ETIOLOGY AND PATHOLOGY—**Almost all acute renal infections are blood borne and etiologically may be divided into two groups: *bacillary* and *coccal* infections. The predominating bacillary infections are those organisms constituting the colon typhoid group. According to one theory these organisms attack that portion of the renal parenchyma distal to the glomerulus; hence drainage into the kidney pelvis is good; therefore the infections usually subside under conservative treatment and never result in parenchymal abscess, carbuncle or perinephritic extravasation of pus. The cocci are prone to attack the kidney as arterial emboli; hence lacking drainage they give rise to multiple cortical abscesses, carbuncle and if they rupture through the capsule perirenal extravasation of pus.

There are two types of kidney infections which deserve special consideration: *Bacillus proteus* and tuberculosis. The proteus bacillus causes a clinical picture no more virulent than that caused by the more common bacilli, but because of its power to split urea and alkalinize the urine it is a prime precursor of stone formation. This organism is the frequent invader in cases of pyelitis; the sequence of events being pyelitis, alkalinization of the urine, *B. proteus* infection and stone formation. It is impossible to acidify the urine from a kidney so infected and Higgins has demonstrated that although the bladder urine may be made acid with an acid ash diet and acidifying agents the urine from the kidney with the proteus infection will remain alkaline.

Renal tuberculosis is a condition familiar to everyone. Suffice it to say that the pathological picture varies from that of acute diffuse pyelonephritis at the onset to abscess formation or pyonephrosis or if the healing process predominates to

tubercle formation cicatrization and sometimes complete healing. That this latter can occur is questioned by many.

**DIAGNOSIS** —The clinical picture of acute urinary infection is that of general sepsis with fever leukocytosis local pain tenderness rigidity and usually pyuria and bacteriuria. In the bacillary infections the last two findings are constantly present and in the coccus infections about 50 per cent of the time in the early stages of the infection. The theoretical reason for the absence of bacteriuria in coccus infections has already been noted.

**TREATMENT** —The management during the acute stage is conservative and includes rest forced fluids and the judicious use of sulfathiazole. Blood nonprotein nitrogen determination should be made since if the infection is bilateral this may become elevated. Determination of the causative organism is of utmost importance for the reasons explained above concerning the difference in the pathological changes in bacillary and coccus infections. If the offending organism is one of the colon typhoid group it may reasonably be expected that in a few days the infection will subside and in time either become chronic or disappear entirely.

With the cocci however the possibility of *abscess* must be borne constantly in mind and if the picture of sepsis does not disappear daily careful abdominal examination should be done in order to elicit increased local tenderness muscle spasm and above all a mass. Also continuous or rising leukocytosis is evidence of a nondraining accumulation of pus. Intravenous pyelograms are helpful to demonstrate distortion and displacement of the renal pelvis due to abscess formation.

If the clinical picture improves to the point of complete subsidence then *cystoscopy* is indicated to determine the presence of any pathological changes mainly obstructive in character which would prevent complete sterilization of the urine. If none are found but the urine does not become sterile *chemotherapy* is indicated checked periodically by cultures of the urine. No patient can be considered cured until the urine is sterile because normal urine is sterile. Therefore as long as the urine

contain bacteria it cannot be considered normal and the patient is a candidate for an exacerbation.

*Instrumentation* in the acute phase of renal infections should be avoided because of the danger of its causing septicemia. It is indicated only when it is felt that information obtainable only by this is indispensable in the further treatment of the condition. *Intravenous pyelograms* should usually be made first but it often happens that an acutely infected kidney is at least temporarily nonfunctioning so that no concentration of the dye is obtained on the side where it is most desired.

Recently the advances made in chemotherapy of renal infections have been of great importance. The most beneficial of these have been in the use of mandelic acid and the sulfonamide derivative. *Mandelic acid* is especially efficacious in the coliform typhoid infections and is given in the form of the ammonium or calcium salt 15 gm four times a day. It is efficacious only when the pH of the urine is less than 5.5; therefore some limitation of fluid intake (usually to 1000-1500 cc daily) is necessary in conjunction with an acid ash diet and the administration of some acidifying drug such as ammonium chloride 0.5 to 2 g daily. This regimen together with the fact that mandelic acid is somewhat irritating to the kidneys precludes its use in the acute infections where irritation is to be avoided and fluids are indicated to combat sepsis. It finds its greatest field of usefulness in chronic infections and should be given for not over ten days continuously.

The *sulfonamide derivatives* especially sulfathiazole are often spectacular in their action particularly in coccidial infections. However there are individuals who seem to be sensitive to these drugs and who have a reaction varying from mild nausea to severe gastrointestinal upsets. Others have skin reactions varying from slight itching to exfoliative dermatitis so that in every case in which the drug is given the patient should be examined daily and determinations of the red cell and hemoglobin content should be made at frequent intervals.

Irrespective of how beneficial the above drugs have proved to be there will be a counterindication which will respond

to neither of them. Therefore it is well to bear in mind that a great many renal infections were cured by forcing *fluids* and *pelvic lavages* before these drugs were discovered and it may be that the future will prove that these older remedies still have a place in combating some renal infections. Neoarsphenamine intravenously 0.3 gm daily for six doses has occasionally proved beneficial in coccal infections.

**SURGICAL COMPLICATIONS**—The surgical complications of renal infection are those which are encountered early in the course of the disease and those which arise after the acute condition has passed. The former are those complicating the coccal infections *parenchymal abscess* *perinephritic abscess* as well as acute surgical conditions which develop as such because of pre-existing renal disease. Surgical kidneys which develop as the result of prolonged chronic infection are almost invariably caused by obstruction due to *strictures* or *foreign bodies* such as stones which are the result of the infection rather than antedating it.

One of the most difficult of urologic diagnoses is to determine when an infected kidney has passed from the stage of acute diffuse pyelonephritis (nonsurgical) to that of *carbuncle* or *perirenal extravasation of pus* (surgical). The reason for this difficulty is that the systemic reaction in the former with a virulent organism may be as severe as it is in the latter with a relatively less virulent one. Therefore the septic state is no criterion. The result is that the urologist is usually in a dilemma and waits until sufficient time has passed to allow a nonsurgical condition to subside. When this does not happen exploratory operation is decided upon.

**Operation**—The operative procedure is to expose the kidney through the loin. When Gerota's fascia is opened induration, serum, and even pus may be encountered. The first two indicate a mild perirenal reaction. If free pus is found the temptation to drain it and terminate the operation is great, but the surgeon must realize that this pus is only that which has ruptured through the capsule of the kidney and that the important accumulation is beneath the kidney capsule; therefore it is

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rather extensive preparation is that if a sudden profuse hemorrhage occurs one is prepared to open the wound quickly and stop it before the patient bleeds to death. If such a hemorrhage occurs in the bed the patient may die before he can be taken to the operating room anesthetized and the wound opened. The removal of the rubber dam can be accomplished with much less danger of bleeding.

**Perinephritic Abscess**—There are many avenues by which infection may occur in the perirenal fat and enclosed within Gerota's fascia such as rupture of a cortical abscess of the kidney, infection of a perirenal hematoma, rupture of a pyonephrosis, extension of infection from a retrocecal appendix and from the female adnexa, all of which invade the renal fossa because of the anatomy of the fascial planes. It is true that perirenal accumulation of pus results and on this basis the term perinephritic abscess is applicable but we believe that the term extravasation of pus is more appropriate because it is incidental to some other local infection and that the name perinephritic abscess should be used only to denote the clinical entity to be described below.

**ETIOLOGY AND PATHOLOGY**—Perinephritic abscess in the sense that we mean is the formation of an abscess around the kidney in which the etiologic agent *always* a coccus usually the staphylococcus sometimes a streptococcus invades the perirenal fat and an abscess results without pre-existing disease in the kidney on the affected side. This may seem to be a distinction without great difference but there is great difference from a surgical standpoint. In the discussion of renal abscess and carbuncle it was stressed that if pus is found in the perirenal fat incision and drainage of the renal fossa do not suffice. The kidney should be exposed and examined because the chief pathological change exists in the kidney and must be corrected. This of course increases the danger of the operation. With true perinephritic abscess incision and drainage are all that is required.

Perinephritic abscess as a clinical entity is a condition in which metastatic infection in the perirenal fat occurs secondary



necessary to expose the kidney in order to determine the exact pathological condition existing there. One of three conditions may be expected: a single large abscess, carbuncle of the kidney, or multiple diffuse cortical abscesses.

If a *solitary abscess* is present, incision and drainage will suffice; if not more than one third of the kidney has been destroyed, if it has, nephrectomy is indicated.

If a *carbuncle* is present, several procedures may be possible. If one pole is involved, heminephrectomy may be done. If the carbuncle is in the midportion of the kidney, debridement with tamponade is possible. If multiple diffuse abscesses are present, nephrectomy is the procedure of choice.

*Technical Points in Resection and Débridement*—The technique of resection and débridement deserves mention. One is operating in the presence of acute inflammation and acute vascular engorgement, which results in considerable bleeding unless special methods are taken to combat it. This is done by compressing the pedicle lightly with a rubber-shod intestinal clamp or by a soft catheter placed around it and tightened just enough to close off the renal artery during the operation. Also this lessens the chance of squeezing any infection into the blood stream in the handling of the kidney. In performing a heminephrectomy it is usually wise to remove the infected area through a wedge-shaped incision in the parenchyma so that the cut edges can be approximated more easily, figure-of-8 mattress sutures being used. After the sutures have been placed and drawn tight but not tied, the constriction on the pedicle is removed in order to be sure that hemorrhage is adequately controlled. If bleeding occurs, it may often be stopped by placing a strip of muscle or fat between the cut surfaces.

The technique of débridement is essentially the same as resection in the preliminary steps, but instead of attempting to close the defect in the cortex, it is packed with gauze, or if there is no bleeding, a rubber dam. If the former is used, it is well when it is to be removed in forty-eight to seventy-two hours to take the patient to the operating room, anesthetize and drape him, and gently remove the gauze. The reason for this

pain. This occurred above the upper pole of the kidney and a small abscess containing about 10 cc of pus was evacuated. This abscess might easily have been missed if the patient had been unconscious.

It is obvious that in all kidney infections foci of infection in the other systems of the body should be searched for and eradicated.

**Kidney Injuries** —ETIOLOGY AND PATHOLOGY —Renal injuries usually are caused by contusion from a blow penetration by a bullet or knife or tearing due to bony injury chiefly fractured ribs. With regard to the first of these injuries it is important to know that the blow necessarily does not have to be a severe one and numerous instances have been reported in which very insignificant trauma has resulted in a kidney injury. In the second of these it should be remembered that in nearly all instances of injury by bullet penetration and in most stab wounds injury of some intraperitoneal viscus also occurs. In the third instance the pleura or peritoneum is very likely to be torn.

Most urological textbooks classify injuries according to type —as capsular, parenchymal, vascular, pelvic and others with various combinations of the types. For brevity and simplicity it may be said that the structures which can be torn are the capsule, the parenchyma, the pelvis and the vessels. Any one of these structures or any combination of two or more may be injured. The important clinical facts to be determined are first whether there is injury in the kidney and second whether it is trivial and may be treated conservatively (nonsurgically) or whether it is more severe and operative interference is indicated.

**DIAGNOSIS** —The majority of kidney injuries are so slight that pain and hematuria (if the tear extends into the pelvis so that blood passes down the ureter) are the only symptoms. These subside with rest in bed, sedation and forced fluids to wash out the blood.

In the more severe injuries where large tears are made in the capsule and parenchyma the clinical picture corresponds

to some distant focus. The focus is usually an infection in the skin (furuncle, boil, carbuncle), the bone (osteomyelitis) or the chest (pneumonia, empyema, lung abscess).

**DIAGNOSIS**—Usually the clinical picture develops very slowly and it may be weeks before the patient consults a physician and by the time he does the original infection may have been forgotten, having been so trivial. The most common complaint is lassitude and a dull pain in the side. Examination in the early stages is often inconclusive. If the patient is hospitalized he may have a slight fever, a degree or two each day, and there may be some leukocytosis (9 000 to 11 000) with no marked change in the differential count. Cystoscopic examination may be negative with sterile urine from the kidney and no distortion or displacement of the kidney pelvis. Abdominal examination reveals some tenderness on the affected side with little rigidity and no mass palpable.

The picture just described is seen in the early stage of the disease. The urologist may be suspicious of perinephritic abscess but the positive findings are not conclusive enough to justify advising operation so it seems indicated to exclude other pathological possibilities which might cause the symptoms such as appendicitis, gastro-intestinal and gallbladder disease, all of which are proved not to be present. Not infrequently by this time a mass is palpable (or x-ray examination shows obliteration of the psoas shadow, scoliosis or distortion and displacement of the renal pelvis) and the diagnosis is established.

**OPERATIVE TREATMENT**—The operative treatment is exploration of the perirenal fat until the abscess is located, opened and drained. These abscesses are sometimes difficult to find, therefore it is often advantageous to employ infiltration anesthesia so that with the patient conscious a localized area of tenderness can be located and explored. In a recent case developed after empyema and pneumonia a local anesthesia was used because it seemed undesirable to give an inhalation anesthetic. When the perirenal area was explored no abscess was found until the patient was asked to say when palpation elicited

tomy can be carried out and if urinary extravasation is found injury to the pelvis or severance of the ureter must be determined and corrected. In all surgical procedures judgment has to be exercised on the basis of the pathological findings and the proper remedial measures executed. The general condition of the patient sometimes allows one to do only those things which in the circumstances are absolutely necessary to save his life.

**LATE SEQUELAE**—Late complications of renal injury are persistent urinary fistulae infection (abscess) in the perirenal hematoma encysted accumulation of a liquefied hematoma. These occur as late sequelae and their diagnosis and treatment are well discussed in all standard urological textbooks they can be diagnosed and treated leisurely at a base hospital and will not be described here.

### URETER

Injuries to the ureter due to external trauma or penetrating missiles are quite rare although some instances have been reported. The symptoms are those of urinary extravasation. The diagnosis is made by intravenous or if this is inconclusive by retrograde pyelography. The treatment is drainage of the extravasation and if the ureter is completely severed anastomosis over ureteral catheter. Subsequent ureteral dilatation to prevent stricture is important.

### BLADDER

Traumatic injuries may result in contusions of the bladder which are of little consequence or they may result in perforations of the bladder with very serious complications.

**Perforation or Rupture of the Bladder**—**ETIOLOGY AND PATHOLOGY**—The injury may be produced in various ways the most common being the *crushing type of injury* involving fracture of the pelvis with perforation of the bladder by a *picule* of bone. *Falls* from a great height or falls in which the perineum is pierced by a sharp object such as a picket fence occasionally occur. It is surprising that gunshot wounds of the bladder do not occur more frequently.

ingly more serious and severe shock is present with the classical picture of hemorrhage. Examination elicits local pain, tenderness and often a mass. If the peritoneum has been torn free fluid is present in the peritoneum. Between the two extremes any degree of local and general reaction is possible depending on the extent of renal damage and hemorrhage plus injury to other organs.

**TREATMENT**—Treatment of renal injuries depends on the extent of renal damage and ensuing hemorrhage. In the more trivial injuries conservative treatment consisting of rest and sedation suffices. In more severe injuries in which the clinical picture and local examination indicate continued bleeding operative interference is necessary.

**Preoperative Measures**—Preliminary to operation certain diagnostic and therapeutic measures are in order. Abdominal examination is necessary to determine the presence or absence of free fluid in the peritoneal cavity. Its presence indicates either coincident rupture of a hollow viscus or a peritoneal tear with intraperitoneal extravasation of blood. If the injured kidney is functioning intravenous pyelograms may give a clue to the extent of the extravasation. When the patient's condition is sufficiently good to stand the instrumentation retrograde pyelography may be done for more accurate knowledge of the condition present. In the final analysis the decision of whether or not to operate soon after injury is made upon the basis of whether or not the patient is continuing to bleed. The conclusion that he is bleeding often rests on increase in the pulse rate, lessening of the perceptibility of the pulse, continuing fall of blood pressure and increasing shock.

The preoperative therapeutic measures to be instituted are rest, sedation, the intravenous administration of fluid and blood transfusions.

**Operation**—The operative procedure depends upon the findings when the kidney has been exposed. If the kidney has been irreparably damaged nephrectomy should be done. If the tear can be sutured and hemorrhage controlled suturing all that is necessary. If one pole only severely damaged heminephrec-

without time consuming procedures. Many patients will have abnormal urinary findings such as gross hematuria and desire but inability to void.

The presenting symptoms in *intrapertoneal rupture* of the bladder may be shock, mild or profound, associated with severe para umbilical pain. Examination will reveal abdominal distention and in a certain number of cases signs of fluid in the peritoneal cavity. Evidence of peritonitis will become more pronounced as time goes on, particularly if the urine is infected.

*Extrapertoneal rupture* of the bladder frequently is a result of a crushing injury of the pelvis; consequently attention may be focused on the injury rather than the rupture. The initial symptoms of extraperitoneal rupture are usually minimal except for possible disturbance in micturition and it is only when there has been progressive extravasation of urine into the perivesical tissues that attention may be drawn to the bladder. Sepsis closely follows extravasation.

Diagnosis of rupture of the bladder may be made without question in a certain number of cases on the basis of the history and physical findings alone. However, if the diagnosis remains in doubt there are certain procedures which can be employed in arriving at a definite conclusion.

Caution should be observed in using any type of urethral instrumentation to avoid introducing infection into an otherwise sterile field.

*Catheterization* of the bladder may demonstrate an empty bladder; on the other hand, as has been reported, the catheter may serve to remove urine from the peritoneal cavity through a large rent in the bladder. Instillation and recovery of a given amount of sterile saline solution has been a time honored procedure but this may be misleading, particularly if the laceration in the bladder is small.

*X Ray examination* of the abdomen following instillation of dye or air into the bladder may reveal the radiopaque medium in the peritoneal cavity or perivesical tissues.

*Cystoscopy* is of questionable value because of the difficulty in locating a small tear when the vision is obscured by bleeding.

**Instrumentation**—A small number of cases of traumatic perforation or rupture of the bladder are due to certain types of instrumentation. With the advent and increasing popularity of transurethral resection of the prostate there are reports of perforation of the bladder by the instrument and in some instances of rupture due to explosion of the gas collected in the bladder.

Litholapaxy should be employed prudently and skillfully lest the bladder wall be taken up in the jaws of the lithotrite and be crushed along with the vesical calculus.

**Overdistention**—The most important contributing cause of rupture of the bladder is overdistention of this or an Overdistention is frequently associated with alcoholism and this combination plus an initiating factor provides the largest group of true ruptures. In a smaller group the overdistention may be due to stricture of the urethra, obstruction at the vesical outlet produced by hypertrophy of the prostate and the obstruction found in certain type of neurogenic disease of the bladder. The rupture of the bladder in all these cases of overdistention may be directly attributable to a relatively inconsequential fall, kick or blow to the abdomen.

A real but rare danger is the overdistention of the bladder while the patient is under spinal or other anesthesia.

**Spontaneous Rupture**—Spontaneous rupture so called is produced by overdistention of a bladder which has some area of weakness in its wall. This weakness may be due to a diverticulum or it may be attributable to changes produced by infection that is, ulcers of the bladder wall or a gangrenous cystitis.

**DIAGNOSIS**—Whether a case of perforated or ruptured bladder is to terminate in death or in return to health depends on the speed and accuracy of the diagnosis.

There are two types of rupture of the bladder—intrapertoneal and extraperitoneal—and the type which has suffered influences to a great extent the immediate and subsequent course of events. The history preceding admission to the hospital may give sufficient information to distinguish the type of rupture.

reau patients who participated in World War I are now approaching what we may term the prostatic age

**CHOICE OF OPERATION**—The surgical measures employed for the relief of prostatic hypertrophy are *prostatectomy* by the suprapubic or by the perineal route and *transurethral resection*. Approximately 15 per cent of all Naval and Veterans Bureau patients with benign hypertrophy are treated by electro-surgical resection and the remainder largely by operation by the suprapubic route. The question as to operative route is considered to be relatively unimportant. It is believed that if one operator has achieved good results for example with suprapubic prostatectomy and if in his opinion it is the operation of choice then this method alone should be employed if the physician is to be fair to both himself and his patient.

Transurethral resection has most emphatically not replaced prostatectomy in the hands of Naval surgeons. It is believed that transurethral resection is applicable to a definitely limited set of conditions but that when so confined its usefulness is unquestionable. It is undoubtedly an ideal method for the removal of the so called median bars for the relief of cicatricial contractures involving the neck of the bladder for moderately enlarged middle lobe hypertrophies for subcervical glandular hypertrophies and for obstruction coincident with inoperable carcinomas. For large prostates where there is great median lobe hypertrophy enlargement of both lateral lobes or enlargement of both lateral lobe coincident with median lobe enlargement we are definitely of the opinion that transurethral surgery is contraindicated in the great majority of cases and that some type of open operation is preferable.

**TECHNIC OF PROSTATIC ENUCLEATION IN SUPRAPUBIC PROSTATECTOMY**—We wish to discuss briefly our method of enucleation in the suprapubic operation. Following exposure of the bladder neck the index finger of the right hand is introduced into the prostatic urethra as far as the apex of the prostate gland. By general palpation along the lateral walls of the urethra the line of cleavage and line of hypertrophy can usually be identified very easily. The urethra is gently broken



A procedure which has been advocated recently and which has been used with some success is the intravenous administration of radiopaque dye and the taking of x rays of the bladder as the dye is excreted by the kidneys. This will serve to demonstrate the presence of dye outside of the confines of the bladder. This method should not be employed in the presence of shock.

Again it must be emphasized that satisfactory results depend on speed of diagnosis and rapid institution of treatment.

**TREATMENT**—Laparotomy is generally indicated in cases of *intraperitoneal rupture* of the bladder. The urine is removed from the peritoneal cavity, the tear in the bladder is closed on the serosal surface and the torn peritoneum repaired and the peritoneal cavity drained. The bladder is then opened and the tear on the mucosal surface repaired. The bladder is then drained suprapubically.

*Extraperitoneal rupture* of the bladder is handled in the same manner except that the peritoneal cavity is not entered. It is very important to establish sufficient drainage of the perivesical tissues in those cases in which extravasation has occurred.

### PROSTATE

The most common surgical disease of the prostate encountered in the Naval Service are benign prostatic hypertrophy, prostatic carcinoma and prostatic abscess.

**Prostatic Hypertrophy**—**INCIDENCE**—The frequency of prostatic obstruction has markedly increased in the period between 1921 and 1940 principally because of the large number of Veterans Bureau patients handled in the Naval hospitals. For example during a recent tour of duty completed by one of us (V. H. C.) at the Philadelphia Naval Hospital seventy-nine prostatectomies were performed in the ten months and of this group only four cases were in active or retired Navy personnel while the remaining seventy-five cases represented Veterans Bureau patients. The reason for this relative increase in frequency of prostatic hypertrophy can readily be understood when one recognizes the fact that the majority of Veterans Bu

In a recent series of seventy nine cases *hemostatic bags* were used in but three cases once when there was severe hemorrhage twenty two days after prostatectomy and once also when bleeding continued beyond the customary postoperative period in the third case a bag was inserted at the time of operation because of an unusual amount of bleeding

We are not advocating this method of prostatectomy and neither are we advocating the nonuse of the hemostatic bag We are simply bringing out the point that the above method has been used with excellent results As a matter of fact at the present time with the numerous satisfactory hemostatic bags on the market such as the Foley bag we can see no reason for their not being used thereby giving both patient and surgeon the feeling of additional security

The suprapubic tube having been sutured into place with No 2 plain catgut is easily removable on the morning of the fifth day The tube is replaced with a metal disk type of suction tube which projects about 1 inch into the wound and is attached to the continuous suction apparatus This tube is changed daily until there is evidence of beginning bladder closure at which point the tube is removed and the suprapubic wound strapped together with adhesive tape Perineal prostatectomy is performed according to the technic of Dr Hu h H Young

**Carcinoma of the Prostate**—Carcinoma occurs in both Navy personnel and Veterans Bureau patients in about the same frequency as reported in patients of equivalent ages in civilian hospitals Navy personnel as a rule are transferred from our Naval hospitals to the Malignancy Service of Memorial Hospital New York City They are usually seen by the Chief of the Genito Urinary Division at Memorial Hospital for an opinion as to the advisability of using radium or radon in the treatment (Radium and radon from a Government deposit are available without charge to Naval personnel at Memorial Hospital but the Navy pays for all medical and other services) Veterans Bureau patients after the diagnosis of carcinoma is established are treated either in the Naval

through at this point on the lateral wall first on the patient's left side and then on the right and the anterior portion of each lateral lobe is then well separated. This enucleation is temporarily discontinued at this point and the index finger with the palmar surface directed toward the posterior urethral wall is withdrawn until the verumontanum is identified. On the proximal side of the verumontanum and between it and the middle lobe the floor of the urethra is now transversely broken through. This technic serves to liberate the verumontanum and ejaculatory ducts from the prostatic mass and in the large majority of cases this maneuver will tend to preserve these structures. If the bladder neck is well dilated the index finger and middle finger then are inserted in the prostatic urethra and hooked over the anterior portion of each lateral lobe which has previously been enucleated and the whole prostatic mass is inveigled into the bladder at the same time peeling off any attached portions of mucous membrane.

Immediately following the removal of the prostate every hot pack is inserted into the prostatic urethra and steady pressure is maintained for approximately three to five minutes. When the hot packs are removed very little bleeding will as a rule be encountered. The frayed edges of the prostatic mucous membrane now are reflected back into the urethra and a second hot pack is inserted. This is removed after a few minutes and any noticeable bleeding points around the neck of the bladder are ligated. The bladder is closed with a standard suprapubic tube sutured in place and with a urethral catheter size 24 cut off squarely and with the external additional opening on the bladder end placed inside the suprapubic tube and secured by a safety pin.

In this type of enucleation the prostate is removed intraurethrally and very little damage if any should be done to the bladder neck. Continuous suction is immediately instituted and continuously maintained. Attention is invited to the fact that no hemostatic bag has been used and no permanent pack left in the prostatic fossa. For a greater number of years so far as (V.H.C.) has carried out this technic and can state that no deaths occurred from postoperative hemorrhage.

forms and followers can be passed and dilatation usually to 22 F can be obtained at the first treatment. After a few days dilatation to 24 F should be effected. This should be followed by dilatation with a Kollman instrument to 30 F or 35 F depending on the resiliency of the stricture. In all of these manipulations *the use of force is to be assiduously avoided* because of the danger of tearing the urethra with the subsequent formation of peri urethral abscess or urinary extravasation. It has been advocated that in very narrow strictures preliminary to instrumentation oil be injected into the urethra in order to dilate it so that filiforms may be passed. This procedure is not recommended since experience has shown that oil emboli may occur which are fatal. Filiforms and followers should be part of the armamentarium of every ship and hospital station.

**OPERATIVE TREATMENT**—The treatment of impermeable stricture with acute retention is surgical. The simplest operative treatment is *suprapubic cystostomy*. When the bladder is opened it is often possible to guide a small sound or filiform through the urethra by a finger placed in it and to dilate the urethra so that a retention catheter may be passed which should be left in situ to splint the urethra. Suprapubic drainage is indicated for from five to seven days until it is safe to remove the suprapubic tube. The urethral catheter should be changed as cleanliness demands.

It sometimes happens that even with the finger in the urethra no instruments can be passed at the operating table. In this situation cystostomy is performed and in the majority of instances it will be found five or six days later that it will be possible to pass a filiform and followers probably because of the subsidence of congestion and swelling in the strictured area.

If after cystostomy the stricture cannot be passed a second operation is necessary. In this preliminary urethral injection of methylene blue solution which is immediately washed out serves to delineate the urethra without having enough left in its lumen to stain and obscure the operative field. An inverted Y incision is made in the perineum and the apex of the prostate exposed in Young's perineal prostatectomy. A small

hospital or transferred to Veterans Bureau hospital where special facilities are available for the treatment of prostatic carcinoma.

**Radical prostatectomy** with a complete removal of the prostate with its capsule, urethra, neck of bladder, both seminal vesicles and ampullae, followed by anastomosis of the wide open vesical neck with the membranous urethra is the only known cure for carcinoma of the prostate. On the other hand, patients who display clinically advanced carcinoma beyond the operative state with urinary obstructive symptoms are afforded relief in Naval hospitals by electrosurgical resection.

**Prostatic Abscess**—Prostatic abscess is quite common in the Naval Service and usually occurs as a complication of gonorrhea. The abscess, once positive diagnosis has been established, is a surgical problem and for this reason every urological surgeon should familiarize himself with the technique of perineal prostatectomy which is essentially the same as that employed for prostatotomy. The practice of making blind stab wound through the perineum for the relief of prostatic abscess definitely is not good urological surgery. A careful dissection with exposure of the posterior surface of the prostate according to the Young technique is indicated with incision and properly instituted surgical drainage.

## URETHRA

The pathological conditions encountered in the urethra of particular interest to the military surgeon are infection, stricture, periurethral abscess and rupture. Of the infections, gonorrhea is of course the most common. Its signs, symptoms, diagnosis and treatment are common knowledge.

**Stricture of the Urethra**—Stricture of the urethra is usually the result of traumatic or chronic infection. The symptom is gradual diminution of the urinary stream with increasing difficulty in voiding and the treatment, dilatation, when the stricture is permeable and operation when the stricture is impermeable to the passage of filiforms.

**DILATATION**—In the majority of instances of stricture filiform

The most frequent site of rupture is the *membranous portion* of the urethra in which case the extravasation follows the course of Colles' fascia in the perineum in the scrotal wall and over the abdomen under Scarpa's fascia but the penis is not often involved because of the fact that Buck's fascia is firmly attached around the base of the penis

If the rupture is in the *prostatic urethra* above Denonvilliers' fascia the extravasation extends retrovesically and retroperitoneally and may later appear at the external urinary ring If it occurs in the upper anterior part of the prostatic urethra the extravasation may appear suprapubically

*Treatment* depends on the severity of the tear If it involves only the mucous membrane rest in bed suffices Repeated examination must be made for extravasation which always requires incision and drainage

#### PENIS SCROTAL CONTENTS EPIDIDYMISS

**Ulcerative Penile Lesions**—*Chancroid*—Excluding syphilitic chancre chancroid is the most common ulcerative lesion of the penis and prepuce It is a painful tender purulent ulcerating lesion usually in the coronary sulcus and by contiguity on the prepuce A frequent complication is fibrosis of the prepuceal meatus requiring dorsal slit in order that local treatment may be instituted The diagnosis having been established by excluding chancre with secondary infection (darkfield examination) the treatment is the maintenance of local cleanliness and administration of sulfathiazole 15 grains four times a day A large proportion of these cases are complicated by infection of the inguinal glands occasionally requiring incision and drainage Circumcision should be delayed until the ulceration is completely healed

*Gonorrhea Inguinale*—*Granuloma inguinale*: a familiar picture to everyone It is important to differentiate it from carcinoma (by biopsy and frozen section) and from lymphogranuloma inguinale (by the Frei test) Treatment is daily injection of 5 cc. of 1 per cent tartar emetic

*Lymphogranuloma Inguinale*—This condition also called

sound is then passed into the urethra until the strictured area is encountered and the urethra is opened at this point and again at the apex of the prostate. The surgeon then has the urethra opened distal and proximal to the stricture and is able with the aid of probes and careful dissection to follow the urethra between these two points. The periurethral scar is then excised, a catheter passed through the urethra and the urethra closed over it. A rubber tissue drain is inserted to the site of the urethral wound.

In the event that it is not possible to follow the urethra between the two openings just described it may be necessary to resect the strictured portion and anastomose the urethra over a catheter which should be left in place for at least two weeks. The catheter may be needed even longer if upon its removal urethral irrigation demonstrates that the urethra has not healed. Failure to heal is indicated by appearance of the irrigating fluid through the perineal wound. If the catheter is removed before complete urethral healing, a persistent urinary fistula will result.

**Periurethral Abscess**—Periurethral abscesses may be secondary to acute urethritis or intraurethral instrumentation in those cases in which excessive roughness has caused a urethral tear. If the abscess is in the *perle portio* it will be confined by Buck's fascia and is characterized by localized swelling, pain, tenderness and fluctuation. Incision and drainage are indicated. The incision should not be directly over the abscess, but should be made about 1 cm. away and the abscess drained by tunnelling under the skin.

Abscesses forming in the *membranous urethra* follow the fascial planes which will be briefly outlined in the discussion of urinary extravasation.

**Rupture or Tear of the Urethra**—Rupture or tear of the urethra occurs as the result of traumatic instrumentation, fractures of the bony pelvis, direct trauma. The symptoms are difficult urination, pain, hematuria, and often urethral bleeding and in more extreme cases, discharge of urine from the wound.

The most frequent site of rupture is the *membranous portion* of the urethra in which case the extravasation follows the course of Colles' fascia in the perineum in the scrotal wall and over the abdomen under Scarpa's fascia but the penis is not often involved because of the fact that Buck's fascia is firmly attached around the base of the penis

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lymphopathia venereum is a disease of unknown etiology in which there is swelling and induration of the inguinal glands sometimes secondary to a trivial penile lesion. It is diagnosed by the Frei skin test. It often subsides spontaneously and if it does not excision of the glands may be indicated. Excision of glands is the only curative treatment and must be done early. In late stages strictures of the urethra and rectum occur.

*Plagedenic Ulceration of the Penis*—This is a fulminating infection due to a Vincent like organism resulting in extensive destruction of the penis and can often be successfully treated by zinc peroxide paste but in severe cases amputation is sometimes necessary. Even so the zinc peroxide paste is valuable in the postoperative treatment.

*Scrotal Contents—Testicular Injuries*—Injury to the testicle is caused by a blow or a penetrating wound and is accompanied by great pain, nausea, vomiting and shock. If the injury is sufficiently severe hemorrhage into the tunica vaginalis may result in a large hematocele which may later necessitate operative correction. If there has been sufficient damage to the vessel the testicle may slough and have to be removed.

*Torsion of the Spermatic Cord*—Torsion of the cord usually occurs in boys at about the age of puberty but may happen later in life. Acute torsion causes great pain, shock, nausea and vomiting. The testicle becomes enlarged and exquisitely tender and if the torsion is not reduced testicular slough may occur. In the less severe instances of recurrent partial torsion with rapid reduction of it atrophy of the testicle may eventually result.

*Treatment—operation*—The testicle and cord are exposed and if the testicle appears to be viable it is sutured to the parietal layer of the tunica vaginalis and a pedicle is taken out to contract the vessel or the epididymis. Because of the not infrequent occurrence of torsion on both sides the retrocally due to inadequacy of the gubernaculum testis it is advisable to expose the other testicle and do an orchidopexy.

*Epididymitis*—The three most important forms of epididymitis are the tuberculous, the gonorrheal and no specific

infections following urethral instrumentation or secondary to chronic prostatitis and seminal vesiculitis

*Tuberculosis of the epididymis* may be acute in the early stages and difficult to differentiate from other infections. It is proved however to attack the lobus major and in time go through the stages of caseation and nodulation so that later examination reveals doughy induration of the epididymis and beading of the vas due to tubercle formation. The skin may become involved and multiple sinuses develop. Epididymectomy is indicated.

*Acute gonorrheal and nonspecific infections* of the epididymis will usually subside with rest, elevation and application of cold but in some cases abscess formation occurs which requires drainage.

The testicle is not often involved in any of these infections except in the late stages. If nontuberculous infections do not subside clinically in a week or ten days even without abscess formation, *epididymotomy* with multiple small incisions in the epididymis has been advocated. There is some opinion that chronic infections of the epididymis chiefly gonorrheal are a source tending to prolong the disease or cause recurrent exacerbations in the urethra, prostate and seminal vesicles. *Epididymectomy* has been advised under these circumstances.

*Technical Points in Epididymectomy*—The technic of epididymectomy deserves a word. It should be remembered that the artery to the testicle lies medial to the vas and epididymis so that if the testicle is turned in the hand the normal relation of these two is disturbed and injury to the artery may occur. Therefore it is wise to avoid turning the testicle and to dissect from the lateral side of the spermatic cord. The vas is isolated and dissected down as far as convenient. The globus minor is separated from the testicle then the body and the globus major. The denuded area at the rete testis is covered by suturing the tunica albuginea over it.



# SHOCK ITS PREVENTION AND TREATMENT

ALFRED BLALOCK M D F A C S

M C M N T AN AN C IE S  
S N RESEARCH C U CIL P ES S ER J H  
H U IVER TY S CH J H L H

THE evidence thus far in the present war indicates that the ratio of wounded to dead is approximately 4 to 1 which is essentially what it was in World War I. The preponderance of shell wound over bullet wounds is probably even greater than in the war of 1914-1918 when 70 per cent were shell wounds resultin from high explosives. The greatest change has resulted from the fact that the employment of more mechanized units has required that the facilities for rendering aid to the injured should be more mobile than in the past. The base hospitals should be at a greater distance from the line of battle. There should be more small hospital and fewer large ones owing to the danger of bombing from the air and the possible necessity for rapid evacuation. In other words it appears that mobile medical units should largely supplant the more or less stationary ones except for those that are at a great distance from the site of the engagement. Greater perfection of organization is necessary. Every unit should be completely equipped. There is an even greater need than in the past for rapid and efficient ambulance service.

## SHOCK

**Pathogenesis**—There is no unanimity of opinion as to the pathogene is of all instances of shock but all are agreed that there is a diminution in the effective volume of the circulating blood. This may be due to a decrease in the blood volume or



**Prevention and Treatment**—Advances in the prevention of shock have more than kept pace with improvements in methods for treating the fully developed condition. After the blood pressure and blood volume remain depressed for a considerable period, general damage to the tissues occurs as a result of the anoxia and no form of treatment results in a sustained benefit. It is for this reason that our major effort should be directed toward the prevention of shock and the most effective form of therapy that is available should be given at the earliest possible moment.

A number of points which are of importance in the treatment of the wounded, with particular reference to the prevention and treatment of shock, will be considered.

### 1 GENERAL CONDITION OF MEN

There is no doubt that the general condition of the person at the time of injury is an important factor in determining the likelihood of the development of shock. It was noted in the war of 1914–1918 that soldiers with adequate fluids did not go into shock as readily as those who had had insufficient fluids. It is desirable that at least 2 liters of *water* in addition to that contained in the food should be available each day and that the quantity should be greater in very warm weather. Food should be adequate in quantity as well as in composition. An abundance of *protein* is especially important. A good state of nutrition increases a person's ability to withstand infections and injuries. Evidence indicates that adequate *vitamins*, particularly vitamin C, are of importance in the healing of wound and in combating infections.

*Exposure to cold* with inadequate clothing increases the susceptibility to shock. This is particularly true if the clothes are wet. Dry garments should be available for replacement.

### FIRST AID DRESSINGS AND SUBSEQUENT CARE

In addition to the control of hemorrhage and the splinting of fractures (points which will be considered subsequently), a number of points of importance in first aid treatment will be

to an increase in the capacity of the vascular bed (vasodilatation) or to both. Most instances of shock which result from trauma are associated primarily with a decrease of the blood volume and vasoconstriction. It is for this reason as will be emphasized later that the main form of therapy consists of supplementing the reduced blood volume by the introduction of fluids rather than inducing vasoconstriction by the use of drugs.

**Clinical Picture**—No attempt will be made to describe in detail the clinical picture of shock, a condition with which all physicians are familiar. The general appearance varies somewhat according to the acuteness of the onset and the severity of the disorder. In *secondary* or *hematogenic shock*—the type in which the loss of fluid is mainly from rather than into the vessels—the findings usually include a rapid thready pulse, cold extremities (vasoconstriction), a pallid or grayish appearance, reduced arterial pressure, collapsed vein, thistly superficial rapid respirations, lessened sensibility, and hemoconcentration or dilution depending on the relative losses of whole blood and plasma and the duration of the disorder. In *primary* or *neurogenic shock* or collapse, which is usually of relatively short duration, the extremities are usually warm (vasodilatation) rather than cold and the pulse may not be accelerated.

It is important to realize that all declines of blood pressure are not of the same significance. For example, a reflex decline of blood pressure produces less damage than a decline of pressure due to the loss of blood. As a result of the compensatory vasoconstriction that occurs in secondary or hematogenic shock, the arterial blood pressure may be normal in the presence of a definite reduction in the blood volume, whereas in the type of shock accompanied by vasodilatation the blood volume may be normal or essentially so when the blood pressure is depressed. Thus, it is evident that the blood pressure is inadequate as a simple guide to the condition of the circulation. When possible, secondary shock should be recognized before the blood pressure declines. The composite picture presented by the patient's condition is frequently a combination of reflex and secondary shock.

lowing receipt of the injury Delayed closure is advisable in older wounds It is inadvisable to perform a primary tendon suture if the wound was sustained more than six hours previously In the care of all wounds the time element is an exceedingly important factor

### 3 CONTROL OF HEMORRHAGE

**Tourniquet**—Hemostasis should be accomplished by measures which interfere as little as possible with the nutrition of the tissues For this reason a tourniquet should not be applied to an injured extremity unless other means of controlling the bleeding are ineffective Wilson and Roome found that the removal of a tourniquet is followed by the passage of a considerable part of the blood volume into the dilated vessels of the extremity and frequently by a decline of blood pressure

If the use of a tourniquet is found to be necessary it should be applied tightly enough to interrupt the arterial inflow to the injured extremity Occlusion of the venous return alone results in more harm than occlusion of both the arterial inflow and the venous return It is desirable unless the part is almost totally destroyed to release the tourniquet every hour in order to allow some blood to enter the extremity The tourniquet should not be covered with a bandage and the patient should be instructed to tell every medical officer who sees him that he has on a tourniquet In addition the fact and time of the application of the tourniquet should be recorded on the patient's Emergency Medical Tags One of the best types of tourniquet consists of a blood pressure cuff but such a cuff is not usually available If a standard tourniquet is not available it may be necessary to improvise one from a belt handkerchief or necktie

**Other Measures**—As has been stated a tourniquet should be employed only when other means for controlling hemorrhage are inadequate Other measures include the causing of pressure on the artery between the wound and the heart elevation of the extremity the application of a tight dressing the insertion of a sterile gauze pack and if adequate facilities are available isolation of the vessel and the use of a clamp and ligature In occa



discussed. The care and promptness of the first aid treatment of open wound are of great importance in determining the likelihood of a subsequent severe infection. It is preferable to leave a wound undressed and attempt no first aid treatment than to treat it carelessly.

The wound should be adequately exposed if necessary by unbuttoning or cutting the clothing. Pathogenic or animal from human source frequently gain entrance into the wound after rather than at the time of injury. Unless profuse bleeding is taking place *wounds should be let alone* except for covering with a sterile dressing until the patient is transported to a place where a septic technic can be observed. An exception is encountered in the care of a sucking wound of the chest. Immediate closure by suture or by the use of adhesive is indicated. It is important to remember that the method for the removal of bacteria and other foreign material from wound should be *mechanical* rather than antiseptic. There are no effective antiseptics which do not destroy tissue. In other words the important point is that wounds should be let alone except for the application of a sterile dressing provided the bleeding has ceased until means are available for proper care. The wound should not be touched with the fingers, unsterile dressing or other unclean objects.

It is too early as yet to assess the value of bacterostatic drugs such as *streptolysins* in the prophylaxis of wound infection. It appears that sulfanilamide in concentrations obtainable by local introduction of the crystalline drug in sufficient amount will protect against infection by holding the organism in check until the local defensive forces have responded. Experience may however not be adequate to supply all persons with active warfare with one of the chemotherapeutic agents to be taken by mouth or applied locally in case of injury.

After the patient reaches a point where adequate facilities are present scrupulous mechanical cleansing of the wound should be effected. Following debridement it may be stated that in general primary closure of wound may be carried out certainly up to eight and usually up to twenty-four hours fol-

ferred from the scene of the injury. In addition to the reduction of pain immobilization results in a lessening of damage to the soft tissues including blood vessels by the sharp bony fragments and for this reason it is particularly important in lessening the further loss of blood.

**Splints**—The Thomas splint for leg or arm is ideal for the splinting of fractures but it is not always available at once. Regimental surgeons should be provided with an adequate number of splints. Most materials at hand such as pieces of lumber make poor substitutes even for temporary use. The substitutes for splints should be padded well on the side that is next to the skin. Further they should be bound securely by bandages or be tied above and below the point of fracture but not directly over it. Fracture of the thigh are particularly difficult to treat by improvised means since it is important that traction be applied. Every effort should be made to obtain the proper type of splint before the patient is transported any considerable distance. The future will witness an increase in the use of wires and pins for insuring fixation and traction.

**Anesthesia for Reduction of Fractures**—*Infiltration anesthesia* has been found to be satisfactory for the reduction of fractures particularly those about the ankle and wrist. The needle is inserted directly into the hematoma and the solution is injected. Satisfactory anesthesia can usually be obtained within five to ten minutes by injecting 10 to 20 cc. of 1 per cent procaine. This method should not be used in cases of compound fracture.

## 6 HEAT

A definite relationship exists between the incidence of shock and the loss of body heat and an effort should be made to prevent and to correct excessive chilling. During the examination and treatment the injured man should be subjected to as little exposure of the body as possible. When possible preliminary dressing of wounds should be performed in a warm place. Heat is lost especially rapidly through wet clothing. Dry garments should be substituted as early as possible. All ambulances should be equipped with heating devices.

sional cases it is necessary to ligate the artery proximal to the wound through a separate incision. The method that is used depends on a number of factors including the nature of the wound and the facilities available for its care.

#### 4 RELIEF OF PAIN

There is evidence that *morphine* in moderate sized doses is of aid in the prevention of shock. Except in the case of severe intracranial damage it should be given for the pain and restlessness associated with injuries before the patient is moved from the scene. While it is possible to administer too much morphine and to add to anoxia already present in shock, usually  $\frac{1}{4}$  to  $1$  grain should be given to the severely injured. *Sodium phenobarbital* in moderate amounts may be given for the restlessness associated with intracranial injuries.

A therapeutic aid of possible value in the prevention of shock may be found in the use of *sodium amytal*. Seeley Essex and Mann found that the tolerance to trauma in experimental animals is definitely greater under sodium amytal or sodium amytal preliminary to ether than under ether anesthesia alone. It is possible that the development of shock may be delayed by such therapy. In so far as I am aware this drug has not been given a clinical trial for this purpose except at the Walter Reed General Hospital where Metcalfe reports favorable results from its use.

Another possible aid in the prevention of shock following injuries to the legs may lie in the production of *spinal anesthesia* as suggested by O'Shaughnessy and Slome. This procedure would appear to be inadvisable inasmuch as spinal anesthesia alone is frequently accompanied by a marked decline of blood pressure.

#### 5 IMMOBILIZATION OF FRACTURES

One of the greatest advances in surgery that resulted from the last war consists of improvements in method of dealing with fractures. Fractures of the long bones should be immobilized by the best means available before the patient is trans-

internal temperature and excessive heat may result in ill effects. Furthermore the patient in shock is usually dehydrated and the application of heat with resultant sweating will exaggerate the condition. These last few remarks are in no sense a criticism of the extremely important principle that the patient should be kept warm but it should be emphasized that a marked elevation of the skin temperature should not be caused unless at the same time the reduced blood volume is supplemented by the introduction of blood or blood substitutes.

### 7 SHOCK POSITION

There is no unanimity of opinion as to the value of the so called shock position in which the foot of the bed is elevated thereby placing the patient's head on a lower level than his feet. Observations made during World War I did not present any convincing evidence of benefit to the patient. However it is possible that lowering the patient's head increases the blood flow to the brain. It is well known that nerve tissue withstands a poor blood supply less well than others. Another theoretical benefit that might be derived from this position is the facilitation of the venous return from the large abdominal vascular area. However since most of the blood is not in the large veins but elsewhere it seems doubtful if the position is important in this respect. There is no proof that the blood of the portal vein can be made to pass through the liver capillaries by gravity drainage. Wells and his associates recently presented evidence that lowering the head and flexing the neck on the chest increase the cardiac output and improve the condition of the animal in shock. It is my impression that the shock position should be part of the therapy of patients in shock.

### 8 VASOCONSTRICTOR DRUGS

A number of vasoconstrictor drugs have been recommended for the treatment of shock. Included among these are epinephrine, ephedrine, caffeine, camphor, neojynephrin, hydrochloride, ether, strychnine, coramine, cardiazol, pitressin, benzedrine, paredrine and paredrinol. As stated previously

**Devices for Supplying Heat**—A number of devices may be used for supplying heat. If *blankets* are available they should be placed around the patient wherever he may be. As Cannon has emphasized, more blankets are needed under the body than over it. The reason is that the blanket protects the body against loss of heat by the air which it holds enmeshed in its fiber. The weight of the body lessens the air space in the fabric and reduces the amount of protection from the under surface. Since there is usually a scarcity of blankets in time of war, they should be used as efficiently as possible.

There are various other means for supplying heat. These include the use of *canteens* or *bottles* filled with hot water and of *warm stones or bricks*. They should be placed outside the clothing in order to prevent burns and should be located between two surfaces such as between the leg or between the arms and the chest. In addition, the patient should be given *hot drinks* unless there are contraindications such as a penetrating wound of the abdomen. The fluid supplements the reduced body fluid in addition to supplying heat. If fluid cannot be retained when given by mouth, as is so often the case in the conditions of the severely wounded, warm liquids may be given per rectum. Marked improvement usually occurs in the cold wounded patient when he is placed in a *warm bed*. It may be possible to place electric lights under a cradle which is over the bed or a lantern may be placed on the floor beneath the bed or stretcher which should be dressed with blankets to provide for retention of warm air beneath it.

**Dangers in Excessive Heat**—It should be borne in mind that excessive heat may result in ill effects as severe as those from excessive cold. In patients in secondary (hematoxic) shock, there is a diminution in blood volume and vasoconstriction. The extremities are cold but this coldness is in part due to the fact that the blood is diverted mainly to the more vital structures of the heart and brain. Excessive heat may cause dilatation of the vessels near the surface of the body and the flow through the more vital parts will suffer correspondingly. Cold extremities may be associated with a definite elevation of the

internal temperature and excessive heat may result in ill effects. Furthermore the patient in shock is usually dehydrated and the application of heat with resultant sweating will exaggerate the condition. These last few remarks are in no sense a criticism of the extremely important principle that the patient should be kept warm but it should be emphasized that a marked elevation of the skin temperature should not be caused unless at the same time the reduced blood volume is supplemented by the introduction of blood or blood substitutes.

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however vasodilation is rarely present in secondary shock except in the terminal stages and induction of further vasoconstriction in early stages may result in harm rather than benefit. The elevation of pressure which follows the injection of such drugs results from an increase of resistance in the tips of the arterial tree. As Cannon has stated damming the blood in the arterial portion of the circulatory system at a time when the organism is suffering primarily from a diminished quantity of blood does not improve the volume flow in the capillaries. Merely a higher arterial pressure is not the aim in the treatment of shock but rather a higher pressure which transmit an increased blood flow through the capillaries all over the body. This can be accomplished in secondary shock only by increasing the blood volume.

In primary or neurogenic shock which is usually of only short duration the use of vasoconstrictor drugs may be indicated. For example the vasodilatation and the decline of blood pressure which may be associated with the production of spinal anesthesia should be treated by the injection of a vasoconstrictor drug such as ephedrine.

In general it may be stated that the employment of vasoconstrictor drugs is rarely indicated in the treatment of shock.

#### 9. INTRAVENOUS FLUID ADMINISTRATION (INCLUDING BLOOD)

Intravenous fluid administration is the most important single form of therapy in the prevention and treatment of shock. The simplest means of producing an increase in a reduced blood volume is giving fluid by mouth. Unfortunately however vomiting is likely to occur if shock is present. Even though vomiting does not occur the absorption of fluid may be greatly retarded and delay is not permissible. If the giving of fluid by mouth is contraindicated it may be administered by hypodermoclysis or per rectum. These routes including the oral one have the common objection that absorption is markedly retarded when shock is present. The importance of not allowing the blood volume to remain depressed and of increasing it at the earliest possible moment has been mentioned. Further

more the intravenous route is the only entirely satisfactory one for the introduction of whole blood and serum and plasma

**Isotonic Salt and Glucose Solutions**—*In Prevention of Shock*—Although normal saline and 5 per cent glucose are indicated at times in the treatment of shock it is in the prevention of shock that their greatest usefulness lie. The best example of their effectiveness is in *dehydration* which may lead to shock and which should be treated by the intravenous introduction of solutions of *crystalloids* if oral or other means of administration are contraindicated or do not suffice. The electrolyte content of the body is severely altered in protracted vomiting or diarrhea and the introduction of an adequate quantity of an isotonic solution of sodium chloride is indicated. In addition water should be supplied in the form of 5 per cent glucose. Among other beneficial effects this solution supplies the kidney with fluid with which waste products may be excreted.

*In Treatment of Shock*—The intravenous injection of isotonic solutions of *crystalloids* in existing shock has at best only a temporary beneficial effect. The fluid passes from the capillaries into the tissue spaces and within a short period the blood pressure and blood volume are as low as before if not lower. Furthermore it has been demonstrated both clinically and experimentally that some of the protein of the blood plasma escapes with the fluid that is lost from the capillaries. This loss results in a diminution of the protein content of the blood plasma and in a reduction of the osmotic pressure. A marked reduction in the osmotic pressure is of grave significance since it results in the further loss of fluid from the blood stream. It is particularly important in the presence of gross tissue damage such as occurs when large masses of muscle are injured that large quantities of normal saline or glucose should not be given intravenously. The same is true in cases of burns. A protein containing fluid has been lost and it should be replaced by a similar protein containing fluid.

It should be emphasized that solutions of *crystalloids* have a place in the treatment and particularly in the prevention of



hock but they should not be used to the exclusion of colloidal solution such as plasma and large quantities should not be given intravenously.

**Hypertonic Solutions**—There are few occasions on which the employment of hypertonic salt or glucose solution is indicated in the treatment of shock. The higher osmotic pressure of a concentrated solution does attract water into the blood stream for a short time but the capillary wall is freely permeable to salts and a rapid filtration into the extravascular space ensues. As has been stated in the discussion of isotonic solutions protein is lost in the presence of capillary damage with the fluid that escapes. Therapy should be directed towards adding fluid to the body rather than toward attempting to attract fluid from the already dehydrated tissue spaces into the blood stream.

The most definite indication for the use of hypertonic solutions is encountered in the shock that accompanies severe *head injury*. A more rational form of therapy in that it reduces the cerebrospinal fluid pressure without adding significantly to dehydration consists in the use of a concentrated solution of dried plasma.

**Gum Acacia Solutions**—Gum acacia solution 6 per cent in 0.9 per cent saline were used to some extent in 1914-19. A number of severe reactions and fatalities were associated with its employment. Although method of preparation have improved somewhat since that time it has gained little if any in popularity. Acacia being colloidal in contrast to salt and glucose remain in the blood stream for a longer time. Damage to carbohydrate and protein metabolism may accompany its use. It is rather generally believed that acacia should never be used if whole blood or plasma is available.

**Whole Blood Transfusions**—Although blood may be obtained for transfusions from the human cadaver the placenta and from suitable donors the latter appear to be at present the only entirely suitable source. A great impetus to the use of transfusions has resulted from the use of *blood banks* which had their origin in World War I. The principle underlying

blood preservation is that the blood corpuscles undergo no noteworthy change if the blood is kept at a temperature between 0 and 5 C. Coagulation is prevented by the use of sodium citrate. The blood should be withdrawn from the donor directly into a container which has been cooled and then placed immediately in a refrigerator. Hemolysis is retarded when large amounts of glucose are added to the blood but the dilution factor is objectionable. Some alterations occur in preserved blood such as the migration of potassium ions from the cells into the plasma but blood which is used within eight days following its withdrawal is usually quite suitable for the purposes under discussion. If evident hemolysis occurs the blood should be discarded. As Plass and others have emphasized the blood should not be warmed before it is introduced into the recipient but should be given in the cold state at a slow rate.

The usefulness of whole blood banks in time of war would appear to be subject to many limitations. A large expensive cumbersome cooling unit is necessary. The length of time that blood can be preserved with safety is limited. Compatibility tests are necessary and these require time and cause delay. The agitation which is associated with transportation probably decreases the length of time that whole blood can be preserved with safety. These and other disadvantages make it impracticable to employ blood banks in the field and in dressing stations and it will probably be only in the base hospitals that a blood bank will prove to be valuable. It was found in the air raid casualties in Spain that at least 10 per cent were of serious enough character to require the transfusion of blood. The effects of the motion of ships and airplanes on the preservability of blood has not been determined.

Nothing has been said about the ordinary methods of direct and indirect transfusions procedures which are familiar to all physicians. Emphasis is placed on blood banks or stocks of blood substitute because they make for less delay in treatment of the wounded. There is the urgency for using blood or some substitute for it as early as possible in order to avoid the ir

reparable damage that accompanies a prolonged low blood volume

*Proper Quantity to Administer*—Apparently because the usual quantity of blood that is removed from a donor is 1 pint the usual quantity that is given to the patient is 1 pint. This is as illogical as giving the same dosage of insulin to all patients with diabetes. The quantity of whole blood or of plasma should be governed by the needs of the patient. If 1 pint is not sufficient to restore effective blood volume it does not follow necessarily that 3 or 4 pints will not result in permanent benefit. One of the greatest advantages of these supplies of preserved blood and plasma is that larger quantities than could otherwise be offered usually are given.

*Blood Plasma and Serum—Rationale of Their Use*—The instances in which the wounded die from the loss of red blood corpuscles are relatively few in number. A person may remain in relatively good condition with a tremendous decrease in the number of red blood corpuscles in the circulation provided that the plasma volume is not markedly reduced. Most persons who die because of the loss of red blood corpuscles do so before medical aid is available.

It is realized that the statements are somewhat inconsistent in that the loss of red corpuscles in injuries is accompanied by plasma loss. The important point and the one that should be emphasized is that the loss of red corpuscles is usually tolerated quite well if the plasma loss is replaced. It is usually unnecessary to replace the red corpuscles if the fluid part of the blood is available for intravenous injection. It is unusual for a patient to lose more than 3 or 4 pints of whole blood as the decline of blood pressure will usually result in a retardation or cessation of the bleeding. This leaves approximately three-fourths of the red corpuscles within the blood vessel. If an adequate quantity of plasma can be introduced the red corpuscles put into more active service are more than adequate to maintain life. The introduction of plasma protein will provide the necessary osmotic pressure to keep the fluid in the cells pro-

vided it is given early and provided the capillary damage is not too extensive

In many types of diseases and in injuries such as burns the loss of the blood volume is almost entirely plasma very few red blood corpuscles escaping. Fortunately the preservation transportation and administration of plasma or serum present far fewer problems than does the use of whole blood. It is a safe prediction that the administration of plasma or serum in warfare will largely replace that of whole blood.

*Sources*—Plasma is obtained from blood which was prevented from clotting by the addition of an anticoagulant such as sodium citrate whereas serum is the fluid part of blood which has been allowed to clot. The most important constituent of each is protein. The main difference is that plasma contains fibrinogen whereas serum does not. The yield of plasma by a given quantity of blood is somewhat greater than that of serum. One of the reasons that plasma has been used more extensively than serum is that after unclotted blood has passed its age of usefulness the plasma may be drawn from it.

*Relative Virtues of Plasma and Serum*—There is some difference of opinion as to the relative virtues of plasma and serum particularly in regard to the safety of administration. Serum is preferred by some physicians because it does not contain sodium citrate and fibrin precipitates do not occur. On the other hand some observers have found that the use of plasma is associated with fewer unfavorable reactions than is the use of serum. This fact is said to be due to the presence in serum of vasodilator or constrictor substances produced in the act of clotting.

*Advantages of Plasma or Serum over Whole Blood*—The use of plasma or serum presents many advantages over whole blood particularly in the treatment of war wounds. Included among the favorable points for plasma and serum over whole blood are the following: (1) they may be stored for months at a cold temperature without significant alteration; (2) they may be kept for a number of days at room temperature the exact length of time not yet having been determined; (3) they

can be transported with less difficulty (4) they can be used without danger of severe reactions without preliminary laboratory typing and compatibility tests particularly if the fluid of different donors is pooled thereby suppressing iso reactions (5) they are ready for instant use and (6) they do not add to the concentration of the red blood corpuscles hemoconcentration being the usual finding in shock. Whereas the use of plasma has enjoyed the greater popularity up to recently the pendulum appears to be swinging to the use of serum.

*Dried Preparations*—When refrigeration facilities are available frozen plasma or serum would seem to meet blood requirements. On the other hand it is obvious that certain advantages including indefinite preservation without regard for temperature as well as easier transportability will result from their conversion into powder. A number of methods of conversion are already available and it is likely that improved ones will be forthcoming. The ideal at the moment appears to be to have as much blood plasma or serum as possible in the dried form. This will reduce to a minimum the problems of preservation and transportation. The plasma or serum can then be brought to the desired volume at the time it is to be given intravenously simply by the addition of sterile distilled water. It is not necessary to warm the solution and it should be given fairly slowly preferably not more than 50 cc per minute. The disadvantages of the dried forms include difficulty of preservation and the time and trouble required to restore them to the liquid state.

Dried plasma should be prepared from liquid plasma that has not been kept in the liquid state for more than two days. It is important that the dried plasma should be protected from moisture by sealing under vacuum in a suitable container. Very little moisture is required to spoil the material. Strumia states that dried plasma which is adequately protected from moisture will maintain its effectiveness in the treatment of shock for an indefinite period of time—certainly for one year at least.

*Conclusion*—To reiterate probably the single most effective valuable and practical method for the prevention and treatment

of shock with the possible exception of methods of hemostasis consists of the intravenous introduction of adequate quantities of blood plasma or serum. Owing to the efforts of many scientists including a committee appointed by the National Research Council and the cooperation of the Army and Navy Medical Corps and various pharmaceutical houses it appears that frozen and dried plasma and serum will be available in adequate amounts for all emergency purposes.

**Other Fluids**—Fluids in addition to those that have been mentioned that may in the future prove to be of practical value in the prevention and treatment of shock include *hemoglobin Ringer's solution ascitic fluid and amino acid mixtures*. The employment of all of these at present is in the experimental stage.

**Comment**—It is important to bear in mind in the treatment of the injured that the intravenous introduction of very large quantities of salt or glucose solutions may actually result in harm rather than benefit. When in the course of treatment it is found that the plasma protein is decreasing while the concentration of red blood corpuscle is increasing one is forced to conclude that plasma is being lost from the blood stream and nothing being accomplished. Tissue edema rather than an effective increase in the blood volume occurs. In these circumstances the employment of a colloidal solution such as plasma or whole blood is imperative.

#### 10 FLUID ADMINISTRATION BY OTHER ROUTES

Brief mention has been made of the use of routes other than the intravenous one for the administration of fluids. The use of the other routes is of much greater value in the prevention than in the treatment of shock. The absorption of fluid is markedly retarded or abolished in peripheral circulatory failure. Unfortunately the patient in shock usually vomits when fluids are taken by mouth. These remarks are not intended in any sense as a criticism of the oral method of administration in those cases in which fluid can be retained and absorbed.

Iso-tonic salt or glucose solutions may be given by *hypo*

*dermoclisis* The site chosen is usually the subpectoral region or the thigh. The latter is usually preferable unless contra indications exist because there is less interference with normal respiratory movements. The most frequent indications for the giving of fluid by hypodermoclisis arise from persistent nausea or diarrhea, peritonitis and various operations on the intestinal tract. These conditions are such as may lead to shock and should be treated by adequate fluid administration.

The *rectal route* is suitable only for the introduction of water. More complicated solutions are absorbed very inadequately when introduced by this route.

## 11 OXYGEN INHALATION

The oxygen content of the arterial blood is usually essentially normal in shock, but that of the venous blood is greatly reduced (stagnant anoxia). The inhalation of 100 per cent oxygen results not only in an increase in the amount of oxygen in chemical combination with hemoglobin but also in a substantial increase in the amount of oxygen in physical solution in plasma. There is a resulting increase in the pressure of oxygen in the tissues. High concentration of oxygen can be more effectively and cheaply administered by use of the Boothby mask than by any other available means. If the respirations are depressed carbon dioxide should be added to the oxygen.

Although there are a good many theoretical and practical reasons for the administration of oxygen in shock, the results of such treatment are not striking. During the exigencies of warfare it is doubtful if the benefits that result would be worth the time and effort. The transportation of large tanks of oxygen presents a difficult problem. Certainly the routine administration of oxygen in shock should not be carried out if it interferes with some of the more necessary and beneficial procedures.

## 12 ADRENAL CORTICAL EXTRACT

Points of similarity between shock and Addison's disease have suggested the use of adrenal cortical extract in treatment.

Potent extracts have been available only in recent years and it is too early as yet to assess the value of this form of therapy. Possible beneficial effects may result from decreasing abnormal capillary permeability or by reducing hyperpotassemia. Scudder suggests that the use of cortical extract should be combined with that of hypertonic salt solution. From the evidence presented thus far it is not justifiable to rate adrenal cortical extract as one of the more valuable agencies in the treatment of shock but the reports on its use are encouraging.

### 13. TIME OF OPERATION

There are many reasons for early operations on the wounded. Particularly are they advisable in those instances in which bleeding cannot be stopped by other means and in those in which penetrating wounds have been received in hollow organ such as the intestinal tract. As has been stated the length of time separating the injury and operation is an important factor in determining whether wounds should be closed by primary suture whether tendons should be sutured and whether shock and other complications will develop following penetrating wounds. In general it may be stated that *the mortality rate varies directly with the hours intervening between the major injury and the operation*. However this does not imply that an immediate operation is indicated if the patient is obviously in too poor condition to tolerate the procedure.

When the general condition of the patient does not permit immediate operation an attempt should be made to improve it by the use of simple measures such as the administration of fluid, warmth and rest. The depressed blood volume should be supplemented by the intravenous introduction of blood plasma or whole blood. If the systolic blood pressure has already fallen to the critical level of 70 to 80 mm. of mercury it must be realized that the condition is very grave, that only a little additional trauma or loss of blood will result in profound shock and that intelligent therapy is required.

When the patient in previously poor condition has been made ready for the operation long and complicated operative pro-



cedures should be avoided and the principal lesion should be treated as quickly as the correct type of surgical technique will allow. At the same time body heat should be preserved every effort should be made to prevent further loss of blood the tissues should be handled as gently as possible and very profound anesthesia should be avoided. In other words careful surgery is indicated but piddling is to be avoided. The results of recent experiment by Beecher indicate that cyclopropane is the best of the general anesthetic agents for patients in shock.

#### 14. PENETRATING WOUNDS

Penetrating wounds do not form a part of this discussion except for the fact that their improper treatment is likely to lead to shock. Several dogmatic statements to which there are undoubtedly exceptions will be made in regard to the surgical care of patients with such wounds.

**Brain.**—All penetrating wounds of the brain are acute surgical emergencies and should be treated by early removal of badly damaged tissue including devitalized bone fragments and the foreign bodies the removal of which will not increase the damage already sustained by the brain. If facilities are available the irrigation suction technique should be used. Such a wound should be closed if operated upon within twelve hours although subsequent reopening may be necessary. Local anesthesia with adrenal added is usually adequate.

**Chest.**—As has been stated sucking wounds of the chest should be closed at the earliest possible moment. If injury to the heart and great vessels can be excluded and if foreign material such as a dirty cloth is not carried into the chest by the aspirator, the injury penetrating wound of the chest should usually be treated by nonoperative means. If the wound is in the left lower portion of the chest, the retraction of the diaphragm abdominal exploration is indicated because of danger of penetration of the stomach or splenic flexure of the colon. If the wound is in the right lower portion of the chest in the region of the diaphragm exploration is not usually indicated. If the site and nature of the injury suggest a threat to the

heart evidence of *cardiac tamponade* should be sought. The two best evidences of cardiac tamponade are (1) suppression or absence of pulsation of the heart under the fluoroscope and (2) a prominence of the veins and an increase of the venous pressure. The treatment of cardiac tamponade is open operation with suture of the heart wound.

**Abdomen**—All surgeons are agreed that exploration is indicated as early as is feasible in penetrating abdominal wounds. Perforations of the intestinal tract should be closed or if it is impossible to close them resection should be performed. Intestinal distention which may lead to shock should be prevented or treated by the employment of duodenal suction, intestinal intubation and inhalations of high concentrations of oxygen. Wounds of the bladder should be closed and a catheter inserted. If the spleen is badly lacerated it should be removed. Unless a kidney is too badly damaged to function it should not be removed.



# MILITARY ORTHOPEDICS

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Military orthopedics is the adaptation of the principles of civilian orthopedics and traumatic surgery to the evacuation and treatment of war casualties. The basic surgical principles in the treatment of a given compound fracture are the same but the conditions under which the treatment can be carried out are quite different.

## MANAGEMENT OF COMPOUND FRACTURES IN CIVIL LIFE

In civil life the transportation of the casualty from the site of the accident to a well equipped and well staffed emergency room in a general hospital is a minor consideration. The time lag is minimal and should fall well within the six hour period of wound contaminations. Proper splinting with a traction fixation splint in fractures of shafts of long bones at the site of the accident is a simple procedure. Its importance is accepted and practiced by all surgeons who treat fractures. The necessity of this type of splinting as a first aid procedure was well demonstrated in World War I. By its use pain is reduced to a minimum and shock as well as further injury to the soft parts of the injured member is markedly prevented.

For many years the Fracture Committee of the American College of Surgeons, both by its own efforts and through those of its Regional Fracture Committee, has carried on a crusade to institute this procedure as a first aid treatment.

On arrival of the patient at the emergency room, if a splint has not been applied to the fracture, one is applied at once.

The first step is to get the patient into a position where the fracture can be treated. This is usually done by placing the patient on a gurney or a table. The next step is to apply a splint to the fracture. This is done by placing the splint on either side of the fracture and securing it with bandages or straps. The final step is to check the circulation to the limb distal to the fracture. This is done by feeling for a pulse and by observing the color and temperature of the skin.

The patient is critically examined by a well trained adequate staff to determine the types of injury that he has sustained and the presence or absence of shock. If shock is present adequate treatment is instituted at once by the use of intravenous replacements such as saline solution, solution of glucose, blood plasma or serum or citrated whole blood. While treatment is being carried out clothing is removed, the wound or wound are examined and x-ray studies of suspected fractures are made. The patient is taken to the operating room and if the fracture is compound thorough debridement is carried out while treatment for shock is continued. The splint is not removed until the patient is anesthetized. The fracture is reduced and fixed in reduction by the method elected by the surgeon. Internal fixation of the fracture by the use of plates and screws is carried out by many surgeons. The wound may or may not be closed. Some surgeons advocate closure if the wound is not grossly contaminated if the time lag is well under six hours and if closure can be accomplished without tension. Several grams of sulfanilamide or sulfathiazole are sprayed into the wound before it is closed. A skin tight plaster cast may be applied or the patient may be placed in bed, the fractured leg suspended on a Thomas splint and weight and pulley traction instituted.

Kennedy and others condemn the primary closure of any compound fracture. After the use of internal metal fixation light saline packs are applied to the wound and a skin tight cast is applied.

Sherman suspended the fractured extremity after internal fixation and irrigates the wound with Dakin's solution. Wilson prefers the Roeder-Anderson dual position reduction fixation method and applies a plaster encasement after spraying the wound with sulfathiazole and using a vaseline gauze pack. He believes that primary closure following proper debridement and spraying of the wound with sulfathiazole and sulfanilamide is a safe procedure even up to eight hours after injury. Orr condemns the use of any of the sulfonamides or up of dressings in the wound. He prefers use of the vaseline pack only, with fixa-

tion of the fracture in plaster. Many of us still are of the opinion that debridement followed by administration of sulfathiazole and use of a bismuth iodoform and paraffin gauze pack (bipp) to be followed by suspension and skeletal traction by means of the modified Thomas splint with infrequent dressings is the procedure of choice. Many compound fractures particularly the comminuted type that result from gunshot wounds cannot be treated physically by internal fixation due to the comminution or loss of substance in the fractured bone.

In civil life the patient goes from the operating room to the bed in the hospital to which he was originally admitted and is under the continuous observation of the surgeons who primarily treated his fracture. As I shall later point out this procedure is impossible in war.

#### WAR INCIDENCE OF COMPOUND FRACTURES

Love's statistics (tabulation) show that more than 30 per cent of all battle casualties which resulted from gunshot wounds in the experience of the American Expeditionary

#### TABULATION

Battle Casualties	Compound Fractures	Simple Fractures	Wounds	Dislocations	Amputations	Other Injuries	Total
1000	Percentage	Percentage	Percentage	Percentage	Percentage	Percentage	Percentage
198.61	4.27	118.23	1.47	3.74	9.46	30.24	4.36
13.36	7.11	133.86	6.09	0.5	17.53	6.79	2.56
4.22	26.98	3.33	11.90	59.19	2.31	10.4	8.45
0.46	37.11	3.64	55.85	10.52	47.68	11.07	66.80

Force were compound fractures. The percentage of deaths in this group was naturally much lower than in the group with gunshot wounds of the head, spinal cord, chest and abdomen. A critical analysis of this table will show that it is mainly the men with wounds of the extremities and face who can be salvaged, returned to duty or later to gainful occupation in civil life.

#### ORGANIZATION OF THE MEDICAL DEPARTMENT OF THE ARMY IN WAR

To understand the military orthopedic problem in war some knowledge of the organization of the Medical Department and the troops they serve together with a simple plan for their evacuation is essential.

**Theater of Operations.**—The Theater of Operations is that area occupied by a military force at war. During World War I it extended from the base seaport in France to the Meuse-Argonne. The Theater of Operations is subdivided into a Combat Zone and a Communication Zone. The *Combat Zone* is occupied by the military forces in contact with the enemy and is subdivided into army area in which the various divisions and the Medical Department installations attached thereto will be found. The *Communications Zone* in which are organized the service of supply to the forward armies and the general hospital of the Medical Department for definitive care of war casualties extends in an overseas expedition from the base port to the forward army area. In fact the sea from the home port in the Zone of the Interior to the base port overseas forms a part of the Communications Zone.

**Medical Personnel.**—A regiment of infantry, as well as all other military units in the field, has medical troops attached to it. At present an infantry regiment has a strength of some 3448 officers and men. It consists roughly of a headquarters and a headquarters company, an anti-tank company and three battalions of four companies each. The attached medical troops are known as a *Regimental Medical Detachment* consisting of eight medical officers, two dental officers and ninety six enlisted

listed men. This detachment is organized into a headquarters section and three battalion sections. The senior medical officer is known officially as the Surgeon, normally holds the rank of major and is on the special staff of the colonel commanding the regiment. The regimental surgeon heads the headquarters section and assigns his three senior medical officers as battalion surgeons.

Each of the battalion surgeons commands a *Battalion Medical Section* which renders service to the regimental battalion to which it is attached. The infantry battalion is the fighting unit of the regiment. Under the direction of the regimental surgeon the battalion surgeon is responsible for the health of the troops in the battalion he serves—in camp, on the march and in combat—and for rendering first aid to all battle casualties and for their proper care and evacuation. The regimental and battalion surgeons must at all times be conversant with the facts of the situation and the intentions of their commander as their problems are markedly changed in a rapid advance, in a break through, in a holding operation or in a retreat.

The battalion medical section is further divided into three sections. Two enlisted men are assigned to each of the four companies in the battalion. They proceed with the company to which they are attached into the attack, render first aid to the wounded and follow the company as it advances. Then the second or litter bearers' section comes forward, applies occlusive dressings, splints fractures, carries the nonwalking wounded by litter and directs walking wounded back to the battalion aid station.

#### MANAGEMENT OF ORTHOPEDIC INJURIES IN THE VARIOUS MEDICAL INSTALLATIONS OF THE COMBAT ZONE

Each soldier carries a first aid packet in his belt along with 6 gm of sulfanilamide which he is to take by mouth if wounded. He is protected by active immunization against tetanus. Vaccination against tetanus by means of plain tetanus toxoid became compulsory in the United States Army in July 1941.



Force were compound fractures. The percentage of deaths in this group was naturally much lower than in the group with gunshot wounds of the head, spinal cord, chest and abdomen. A critical analysis of this table will show that it is mainly the men with wounds of the extremities and face who can be salvaged, returned to duty or later to gainful occupation in civil life.

### ORGANIZATION OF THE MEDICAL DEPARTMENT OF THE ARMY IN WAR

To understand the military orthopedic problem in war, some knowledge of the organization of the Medical Department and the troops they serve together with a simple plan for their evacuation is essential.

**Theater of Operations**—The Theater of Operations is that area occupied by a military force at war. During World War I it extended from the base camp in France to the Meuse-Argonne. The Theater of Operations is subdivided into a Combat Zone and a Communication Zone. The *Combat Zone* is occupied by the military force in contact with the enemy and is subdivided into army area in which the various divisions and the Medical Department installation attached thereto will be found. The *Communications Zone* in which are organized the service of supply to the forward armies and the general hospital of the Medical Department for definitive care of war casualties extend in an overland expedition from the base port to the forward army area. In fact the sea from the home port in the Zone of the Interior to the base port overseas forms a part of the Communications Zone.

**Medical Personnel**—A regiment of infantry as well as all other military unit in the field has medical troops attached to it. At present an infantry regiment has a strength of some 3448 officers and men. It consists roughly of a headquarters and a headquarters company, an antitank company and three battalions of four companies each. The attached medical troops are known as a *Regimental Medical Detachment* consisting of eight medical officers, two dental officers and ninety-six en-

At the battalion aid station a litter is prepared with blankets so as to maintain the body heat of the patient. The splint is adjusted as indicated and fixed to the litter. Hemorrhage is controlled if present. Sulfanilamide 6 gm is administered by mouth if it has not already been ingested. Administration of

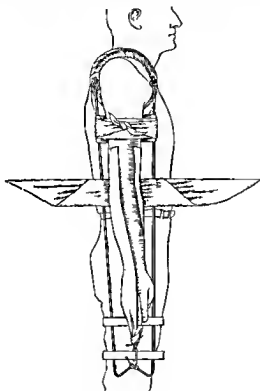


Fig. 357.—H b l t l m pl l t t t t pl t l m  
 m b l t f f t b l th b ld d b f th m d f  
 m bo th m d d l th d Adh pl l sed l bt k t t  
 f f t

sulfanilamide is to be continued in 1 gm doses every four hours during the evacuation of the patient and until discontinued by order. Morphine sulfate is administered in  $\frac{1}{4}$  grain doses to relieve pain. In the Combat Zone morphine sulfate will be available in solution in a collapsible tube with an at

Troops in tropic America are likewise immunized against yellow fever.

**Litter Bearers Section**—Compound fractures are splinted and the patients are transported by the litter bearers section to the battalion aid station. Cloth about the wound is cut away; the skin adjacent to it is painted with tincture of iodine which the medical soldier carries in a special container and an occlusive dressing is applied. The *army linged halfpin splint* (modified Thomas) is applied to major fractures of long bones of the lower extremities above the ankles and a *hinged traction arm splint* to fracture of the upper extremities (Figs 356 and 357). These splints afford fixation traction for transportation.

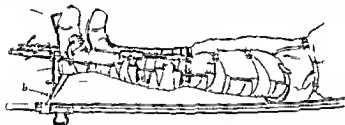
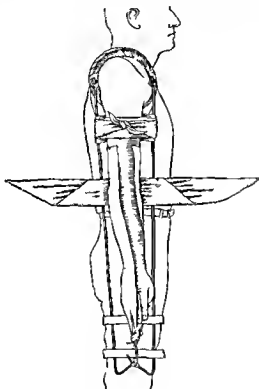


Fig 356—Army Lined Halfpin Splint. The splint is applied to the limb and the patient is transported. The splint is made of metal and is lined with cloth. It is used for fractures of the long bones of the lower extremities. The splint is applied to the limb and the patient is transported. The splint is made of metal and is lined with cloth. It is used for fractures of the long bones of the lower extremities. The splint is applied to the limb and the patient is transported. The splint is made of metal and is lined with cloth. It is used for fractures of the long bones of the lower extremities.

**Battalion Aid Station**—In a hold-up attack the battalion aid station is established from 300 to 800 yards behind the advance lines of the infantry battalion. It is located so as to be sheltered from direct artillery fire near water if available and in line with the natural drift of the walking wounded. The equipment for establishing the aid station is carried by truck and consists mainly of dressing bands, drugs, splints, litters, blankets and tentage. The battalion surgeon is responsible for the collection, treatment and evacuation of the wounded of his battalion to his battalion aid station and the preparation of them for further evacuation to the rear.

At the battalion aid station a litter is prepared with blankets so as to maintain the body heat of the patient. The splint is adjusted as indicated and fixed to the litter. Hemorrhage is controlled if present. Sulfanilamide 6 gm is administered by mouth if it has not already been ingested. Administration of



F b 357 H g d t t pl t t t l t pl t f m  
 m b b t f f t b th h kd d b f th m d f  
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sulfanilamide 1 to be continued in 1 gm l o e every four hours during the evacuation of the patient and until discontinued by order. Morphine sulfate 1 administered in grain d o e to relieve pain. In the Combat Zone morphine sulfate will be available in solution in a collapsible tube with an at

# EVACUATION IN ZONE OF ADVANCE

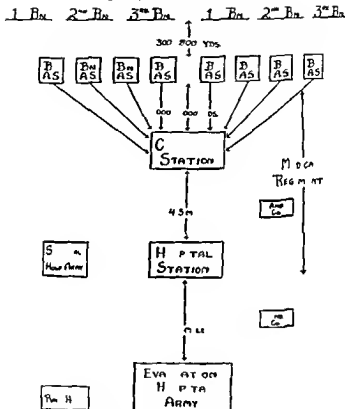


Fig 358—A d r m m p s e f p l f c u a t i s e  
 i h t h p e b l h i p r t a n g t u n T h b a l o n  
 and s e a l f h f t d d f h p l t u g d p p  
 t f t n s p o f l e s h f m a n f t h  
 m f f h t p  
 Th b e f p t t t y t p o t t t h e  
 h m b l s e l b l T h d h b y p e r s o n n l l  
 th b t l d t a t b y h l t s e f t h l l c t i n g  
 p y  
 A f r t g l f e a t d s e f b l l  
 l k s e s e t a l H f t h f i r s t m h k c a b e t r e t d b y i n t r a c s

attached sterile needle Sodium amytal has been shown in experimental work on animals by Mann and others to delay the development of shock and it may be well to use it at this time Shock if present is treated by elevation of the foot of the litter and administration of hot drinks caffeine and sedatives

All casualties are tagged. The tag gives the name, rank and organization of the patient, his major wounds, where he was wounded (geographically), the time of day and the date on which he was wounded and the medication administered to him. No surgery is attempted at this station except first aid. A bleeding vessel may be clamped and ligated. A tourniquet may be applied if ordered by a medical officer. A traumatic amputation may be completed by a snap or two of a pair of scissors and the patient, if not in shock, prepared for evacuation to the rear.

*Evacuation of the Wounded*—Evacuation from the battalion aid station through the collecting station to the hospital or clearing station some 5 miles to the rear is carried out by the elements of the medical regiment in the square division or the medical battalion in the triangular division (Fig 358) When evacuation by ambulance is impossible litter patients are carried by hand or wheel litter and those who can walk are directed by the litter bearers section of the collecting company to the collecting station situated 1000 to 2000 yards to the rear of the battalion aid station

**Collecting Station**—The collecting station is larger and more elaborate than the battalion aid station but its equipment is similar. One collecting station will serve three to six battalion aid stations. Patients are examined, recorded on admission,

pl m t      g bl d pl m sal      d gl      Th      i bl h d by  
lh k p tal      l g t t      f th d      l m d l t p  
lf pl      amb l      e      is t      l bl f f th      mm d t trans  
port c      t g      l h p tal      th C mm      t Z      g al k p t l  
i lh d      l      t k p tal      t th      r al h d      ce sary t  
leve th      l m l g      h m t t      p r t u      s d O ly      l h se tal  
ll      ca d b d m t f      ds      d p m y      d q t      g l l rve  
t      be      l l led  
R 4 S B l tal      A i St t

checked for shock. Their dressings are inspected, reinforced or changed, and tourniquets are loosened and splints readjusted. In addition, the patients are prepared for evacuation by ambulance to the hospital or clearing station, some 4 to 5 miles to the rear.

**Clearing Station.**—The hospital or clearing station is located beyond rifle range, sheltered from direct artillery fire, near a good road leading to the rear, far removed from ordnance dumps, artillery placements or other troop concentrations. Distance to the rear, however, cannot protect this installation in total war from aerial bombs, which have the same effect as artillery. Tents are pitched to shelter the wounded if buildings are not available. Buildings and tents require camouflage to protect them from air attacks. A receiving department or triage is established to examine critically all cases on admission. Patients slightly wounded and those fit for duty are returned to their organizations. Those in shock are admitted for treatment to the shock section, where intravenous replacement normal salt and glucose solution bottled and ready for use will be available, along with dried blood plasma. Patients whose splints need adjustment or whose wounds require inspection or redressing are admitted to the surgical section. Those patients requiring no further care are transferred to the evacuation section, fed and cared for there until evacuated by army ambulance or air ambulance either to the evacuation hospital, some 10 to 20 miles to the rear, or to the general hospital in a Communications Zone.

**Surgical Hospital.**—Little or no surgery is attempted in the hospital or clearing station unless the station is acting independently far in advance, supporting a breakthrough of a mechanized unit or triangular division. Head chest, abdominal bleeding, and nontransportable cases are transferred at once from the triage to the adjacent surgical hospital, which has been established in the divisional area by the Army. The surgical hospital represents a small section of an evacuation hospital brought forward to the wounded. It has full surgical facilities for emergency operative procedure. Its personnel may be sup-

plemented by surgical splint and shock teams from general headquarters reserve. The belief has been expressed that consideration should be given to the plan Jolly used in Spain for two years. He supplemented the hospital or clearing station with self contained operating teams as required. The hospital or clearing station became the housekeeping unit providing hospitalization for postoperative cases.

**Evacuation Hospital**—The evacuation hospital ordinarily is established on a railhead since transportation of wounded to the general hospital in the Communications Zone is by hospital train and the unit with its equipment is heavy and bulky. It has a capacity of 750 beds and is housed in existing buildings or in its own tentage. This hospital is completely equipped to give adequate emergency surgery and to afford postoperative care. A detailed account of its complete organization and function will be omitted. The patient with a gunshot fracture arrives here after having been transported by a litter carrier and motor ambulance over various types of terrain under rifle and shell fire and under anything but ideal conditions. He arrives on his original litter with his fracture immobilized in the original splint. The evacuation hospital corresponds to the emergency room of the general hospital in civil life. Postoperatively after remaining here a few hours to a few days he will be transported again by rail or air to a general hospital for definitive care.

The time lag before debridement in the evacuation hospital will depend upon several factors: air equality or superiority, availability of road space because supplies, ammunition and troops going forward have preference over ambulances returning, type of road, weather conditions and the fact that evacuation may be possible only at night.

Ambulances should be of the four wheel drive type supplied to the infantry. Ideally the truck bodies should be made splinter proof being constructed of some type of thin especially hardened steel (armor plate) and the driver should be protected by a bullet proof glass wind shield. Also ambulances should be heated.



*Management of Patients*—All patients are critically examined on admission to the evacuation hospital. They are classified as follows: slightly wounded, seriously wounded, in shock, bleeding case, gas cases, medical cases, compound fractures, and so on. Appropriate steps are taken so that indicated treatments may be instituted at once. The chief of the surgical service determines the priority of treatment in surgical cases according to the urgency of the case. Cases of hemorrhage and compound fracture are sent at once to surgery unless the patient is in shock. Thorough debridement of all wounds is carried out after fluoroscopic study to detect the presence of foreign bodies and the nature and extent of fracture. Shock cases are treated in shock ward by intravenous replacements with bottled salt and glucose solution, dried blood plasma or citrated whole blood.

The roentgenologist reports his findings by sketching and in writing to the chief of the surgical team on whose table the patient is placed. The patient is anesthetized and the splint is removed by the splint team. Traction is maintained while the extremity is prepared for surgery. *Debridement* is performed; that is, the skin and fascia immediately surrounding the wound are thoroughly excised; the length of the incision is increased both in the skin and fascia so that all traumatized muscles may be exposed and removed; large blood vessel and nerves are avoided; all foreign bodies are removed, as are fragments of bone not attached to the periosteum and those which have lost their blood supply. The wound is thoroughly irrigated with normal salt solution or Dakin solution and after all eschars are sloughed, several grams of sulfathiazole are sprayed into the wound and it is packed open with gauze soaked in paraffin or with bismuth iodoforn and paraffin gauze (b.p.p.).

If the wound is twelve or more hours old and is infected rather than contaminated, foreign bodies are removed and the wound is widely opened to establish drainage, but a true debridement at this time is not considered advisable.

When the surgical team has finished its work, the splint team reapplies the army hinged half ring splint. To apply it they

use either skeletal traction with a Steinmann pin through the os calcis or skin traction to maintain length and alignment. Then the patient is transported in fixed traction to the ward to await further evacuation to a general hospital. He is treated until transported.

*Primary closure of wound after debridement* was banned by order during World War I because severe infection often followed it. Even with the advantages of the new chemotherapeutic drugs primary closure is considered hazardous. All surgeons agree. I think that thorough debridement is indicated but there is considerable disagreement over what should follow this in the handling of compound fractures.

*Anticipated Number of Casualties per Day*—The tabulation given earlier shows the percentage and types of wounds to be anticipated so it might be well to consider the number of casualties to be expected each twenty-four hours from a division that an evacuation hospital supports.

The daily percentage of battle casualties in a severe engagement may be estimated as: infantry regiment 12 to 15 per cent; infantry division 6 to 8 per cent; Army corps 3 per cent. The ratio of killed to wounded is 1 to 4; the ratio of killed to wounded and gassed is 1 to 6. Prior to the war of 1914–1918 rifle bullets caused 80 per cent of wound and shell caused 20 per cent. In that war this ratio was reversed: shells accounted for 80 per cent of wound; rifle and machine gun bullets for 20 per cent. Air bombing will increase shell wound casualties. It is more accurate to estimate battle casualties in an army on the basis of the number of divisions actually engaged than to use a rate based on the casualties of a corps or army. Included in the total casualties to be cared for are those of the enemy left on the field. The battle casualties of a division of 16,000 men having an 8 per cent casualty day may be estimated as follows: dead 20 per cent or 256; able to walk to collecting station only 40 per cent or 512; requiring litter transportation 40 per cent or 512 (2 per cent of patients nontransportable beyond surgical hospital 24); total 100 per cent or 1,280. Total number to be evacuated by am-

balance to evacuation hospital 1003 (491 of these will be litter patients 512 sitting case) In World War I more than 2000 patients were received in a twenty four hour period at a certain evacuation hospital

### CLOSED METHOD OF TREATMENT FOR COMPOUND FRACTURES

The closed method of treatment of compound fractures popularized by Trueta in Spain advocated by Orr and first described by Ollier in 1885 has been accepted by many surgeons as ideal both for immediate treatment after debridement and for definitive care

**Spanish War Experience**—Trueta after performing debridement of a wound reduced the fractures by traction and countertraction. He used an orthopedic table packed the wound with plain gauze and applied a skin tight plaster cast. He reports 1073 patients were given this treatment in his hospital. In only eight of the cases did he have to remove the encasement because of infection and in only one case did gas infection occur. He states that approximately 10 000 wounded treated by the closed method survived the retreat from Caldonia and arrived in France. He further states that the general consensus of opinion (French surgeons) was that the results were entirely satisfactory and that Arnaud found only one case of gas gangrene in 800 wounded which had been so treated.

Arnaud and associates in February and March 1939 observed 2000 of these wounded 600 of whom had been treated by the closed method from fifteen days to six months prior to their observation. Patients with gas infection naturally would not have survived. The surgeon found that soft tissue wound had healed satisfactorily. Fifty per cent of the compound fractures showed mediocre results. Malunion and nonunion with overriding of fragments deformities excessive callus and multiple equities were the rule. The best results were in the upper extremities particularly in the metacarpals. All fractures of the femur showed bad results and no wounded joint was

without complicating infection. Many fractures showed suppurative dissection of the subcutaneous and subaponeurotic tissues particularly of the thigh and calf with secondary joint involvement or metastatic abscess. Such cases showed no clinical evidence of suppuration such as edema, temperature elevation or pain, but many of the patients appeared to be cachectic and suffered from diarrhea.

Arnaud does not advise the systematic use of the closed treatment. He is of the opinion that it permits evacuation of the patient in excellent condition for a wounded man without great risk and little pain, but that it should not be used in definitive care of compound fractures. To quote: "The difficulties of supervision of the wound under plaster are certain and we cannot forget the great suppuration and far reaching arthritis which we have discovered after the removal of the cast and which no revealing symptoms permitted one to suspect."

Apparently in certain of these cases the closed method neither prevented infection in the wound after debridement nor did it immobilize the fracture properly. Apparently it did prevent pain and allow patients to become ambulatory and easily transportable.

**Fractures Resulting from Air Raids**—In cases of compound fractures sustained in air raids, Matthews sprays the wound liberally with sulfathiazole and sulfanilamide in the proportion of 1 to 3 after surgical excision and immobilization of the limb in plaster of Paris encasement which is cut from end to end and windowed over the wound. He acknowledges that the closed method has produced many spectacular successes but does not believe it is the best way in which to treat air raid casualties in big cities because tragedy often occurs when a patient passes from the care of one hospital to another. The fracture needs to be constantly and carefully watched. Dr. Broder, Senior Surgeon, Charing Cross Hospital, London, told me himself that he concurs fully in Matthews' views.

**Contraindications**—Soule and Linares, who advocate the closed treatment, believe that immediate employment of the technic at the time of wound excision is contraindicated in the

following conditions (1) if there is a vascular lesion that may cause gangrene (2) if the wound is of such a type that all devitalized tissue cannot be removed (3) if the time is more than twenty five hours (4) if there is any suspicion of the presence of gas gangrene (5) if the fracture has not or cannot be reduced except by continued traction (e.g. open fracture of the shaft of the femur)

Jolly who also recommends the closed treatment immediately following debridement states: After application of plaster no case should be evacuated without at least twenty four hours observation in the forward hospital.

Gissane is of the opinion that the Thomas splint should be used in transportation and that plaster should not be used for immobilization of compound fractures until arrival of the patient at a general hospital because when the Orr technique is used there is danger of the development of secondary hemorrhage and gas gangrene. The latest German medical literature on the treatment of war wounds states that during transportation a modified Thomas splint is used for immobilization of fractures of the lower extremities.

**Closed Method in Osteomyelitis**—The closed treatment is ideal for the treatment of acute metastatic osteomyelitis as well as for the treatment of chronic osteomyelitis or bone abscess following equestrectomy and debridement in those cases in which there is no loss of continuity of the bone. There are no devitalized muscles, no open contaminated wounds. The tissues have built up a certain resistance to chronic infections in the same manner as does the peritoneum. There are no gas bacilli, tetanus spores or virulent foreign streptococci to produce a fulminating cellulitis or gas gangrene. The patient is prepared in advance of planned surgery by chemotherapeutic medication and the powdered drug is liberally sprayed into the wound. Bismuth iodoform and paraffin gauze (bipp) is preferred to the vaseline pack as it is by Gudd. I have used it for the past fifteen years and consider it superior to vaseline. Liquid paraffin as a base is less gaseous than vaseline. Gauze impregnated with liquid paraffin packs into the wound more readily. Granula

tions are much more healthy and the wound and dressing do not become odorous as when packed with vaseline. Unfortunately bismuth iodoform and paraffin gauze is impervious to x ray

**Fractures of Shafts of Long Bones**—It is not believed that fractures in shafts of long bones can be immobilized in plaster encasements alone even if encasement follows anatomical reduction unless the fracture is transverse. Even in the case of transverse fractures angulation frequently occurs regardless of whether the plaster is applied skin tight or padded. If a plaster could be made so that the shrinkage in the encasement kept pace with that in the soft tissues of an extremity such a plaster would be ideal.

**Problems of Fragment Fixation**—Kennedy, Darrah, Wilson and Clay Murray insist that fixation of bone fragments must be complete after debridement or their movement will cause infection in a contaminated wound. Perfect fixation can not be obtained merely by placement of the limb in plaster encasement. Proper length and alignment in fracture of the shaft of a long bone cannot ordinarily be maintained without fixation. The fixation may be of the internal type. Also fixation may be effected by means of pins thrust through and through respectively above and below the site of fracture. The pins are incorporated in the plaster and obviously the fixation is lost when the wound is dressed. Roger Anderson dual pins may be used or the Haines system of fixation by pins may be employed. Moreover skeletal traction can be exerted through a pin or a Kirschner wire can be incorporated in the encasement. Pin fixation is accompanied by dangers of bone infection even when used in the treatment of simple fractures.

We are told that plaster encasement is necessary to put the parts at rest to prevent frequent dressings to allow and promote tissue healing and to prevent secondary wound infection. Yet when fixation of compound fractures is carried out by the various pin methods the walking casts or metal stirrups are frequently applied and the patient is early made ambulatory. Can this be considered rest of the muscles of the extremities or of

the fracture site? The weight is carried through the pins inserted into the bone fragments to the plaster encasement. Does a surgeon have to apply plaster encasement over a wound to prevent himself from dressing it daily and causing reinfection?

Mr. Thomas, uncle of Sir Robert Jones, developed and used his splint with fixed traction to put at rest infected knee and hip joints and promote healing in them. The Thomas splint or a modification of it, skeletal traction, debridement and the debriding of compound fractures, although arduous for the surgeon and painful to the patient, was the outstanding contribution to the treatment of gunshot fractures in World War I. It will be interesting to see what method replaces it in the present war. The chemotherapeutic drugs undoubtedly will play a leading role in the prevention and control of infection in conjunction with tetanus toxoid.

# MANAGEMENT OF FRACTURES IN THE UNITED STATES NAVY

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THE definitive treatment of fractures occurring among Naval personnel where such treatment is given in our large Naval hospitals differs little in clinical and technical details from that commonly employed in the best civilian institutions. There are, however, certain problems peculiar to the United States Navy which modify our management of this type of trauma. Some of these problems are occasioned by the occurrence of fractures on board ships by the transportation of such cases and by the administration of definitive treatment to many on our larger combatant ships and on hospital ships. The management of fractures occurring in peacetime with special emphasis placed upon the above problems peculiar to the Navy will be discussed with the hope that their consideration will prove of general interest and may give prospective medical officers some understanding of the method employed and thus may prepare them

This publication is intended to be distributed to the Navy Department and the Naval Service in large quantities for the purpose of making it available to the new members of the service.



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for the care of wartime casualties should this eventuality occur

### INCIDENCE

Tables 1 and 2 give a brief summary of our typical Navy peacetime (1938) fracture incidence

TABLE 1

INCIDENCE OF FRACTURES IN THE U S NAVY (1938)

	Total	Fractures	Percent
Admissions to hospital	54,810	2,105	3.84
Sick days	1,160,310	81,877	7.06
Incidents of injury	1,464	47	3.21
Deaths	362	3	0.84

TABLE 2

CLASSIFICATION OF FRACTURES BY LOCATION

Upper extremity	1031
Lower extremity	63
Spine	66
Thorax	67
Pelvis	26
Skull	75

**Increase Due to Naval Expansion.**—Since the statistical report was prepared a great expansion of the Navy has taken place resulting in a marked increase both in numbers and in variety of fractures. It is inevitable in such an expansion that rapidly trained and therefore relatively inexperienced personnel handling many types of powerful and high speed machinery will come to grief more frequently than the men whose trauma constituted the figures above. Two recent cases aptly illustrate this etiological element. A seaman painting on the catwalk of an aircraft carrier was sitting with his legs hanging over the edge of the catwalk. On the deck below a boat crane was being swung into position. The seaman's legs were struck by the crane and pinned under the catwalk with resulting extensive fractures of both tibiae and fibulae. A young seaman with a number of other men was riding on an open trailer full of stores when in some unexplained manner the trailer broke

lode from the towing truck. The seaman jumped to the roadway and sustained a comminuted fracture of the femur. The other men who stayed with the trailer were uninjured. We may assume that under existing conditions casualties will be large and every facility for the rehabilitation of these cases must be used to maximum advantage.

As regards *causative agents* in the foregoing tables strictly Naval and military hazards accounted for 468 fractures and the remainder 1637 were due to ordinary industrial and miscellaneous hazards of which motor vehicle accidents constitute a predominant group. Although Naval vessels and large shore establishments are actually major industrial units accidents from such causes have been kept at a creditable minimum by safety precautions and careful training of personnel. We can therefore expect a probable relative as well as actual increase in industrial accidents and miscellaneous hazards should while actually much greater maintain approximately the same relative importance as previously.

**Modern War at Sea**—It is difficult to make an estimate as to what can be expected should hostilities eventuate. Modern naval engagements often last for relatively brief periods a matter of minutes even and when concluded or temporarily stopped can present the medical officers with a staggering problem in the care of the wounded. Data from recent engagements in the present war however seem to indicate a higher percentage of deaths and a lower percentage of injuries among casualties as compared with previous World War figures. Fracture caused by penetration of explosive fragments bullets splinter and falls from the force of exploding bombs will naturally constitute the major part of increased casualties. Any estimate of expected casualties must be based on the experience of others in the present conflict and the figures used after major naval engagements have been meager. In general however the ships involved in actions of importance during the present war have been those whose armor protection is relatively light and which are vulnerable to direct hits by hellfire torpedo and heavy

for the care of wartime casualties should this eventuality occur.

### INCIDENCE

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TABLE 1

INCIDENCE OF FRACTURES IN THE U. S. NAVY (1938)

	Total	Fractures	Per cent
Admissions to hospital	54,810	210	3.84
Sick days	1,160,310	81,577	7.06
Invalided from service	1,464	47	3.1
Deaths	362	32	8.84

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Skull	75

**Increase Due to Naval Expansion.**—Since this statistical report was prepared a great expansion of the Navy has taken place resulting in a marked increase both in numbers and in variety of fractures. It is inevitable in such an expansion that rapidly trained and therefore relatively inexperienced personnel handling many types of powerful and high speed machinery will come to grief more frequently than the men whose trauma constituted the figures above. Two recent cases aptly illustrate this etiologic element. A seaman painting on the catwalk of an aircraft carrier was sitting with his legs hanging over the edge of the catwalk. On the deck below a boat crane was being swung into position. The seaman's legs were struck by the crane and pinned under the catwalk with resultant extensive fractures of both tibiae and fibulae. A young seaman with a number of other men was riding on an open trailer full of stores when in some unexplained manner the trailer broke

*Medical Personnel*—The medical personnel assigned to destroyers usually consists of one medical officer to a division of destroyers (four to six ships) and one hospital corpsman usually a chief or first class petty officer to each ship. Smaller craft having medical personnel are provided with one hospital corpsman.

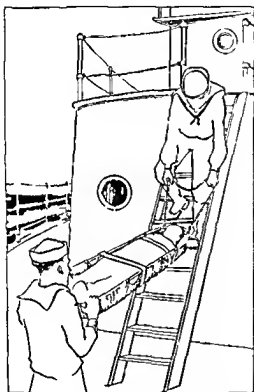


Fig. 360—The Stretcher Carrying platform ship ladder (U.S. Naval Bulletin)

*Equipment*—This is of necessity meager consisting of a minimum of medicinal substances bandages and other first aid materials a few temporary plints and a Stokes stretcher. This stretcher is standard in the Navy and has proved well adapted to requirements both afloat and ashore (Figs. 359-363).

bombs Under the e conditions ca ualties can be expected to comprise more deaths and fewer injuries Of the injuries extensive compound fractures should constitute a large percentage

#### THE MANAGEMENT OF FRACTURES AT SEA

**Small Ships**—The Navy has an abundant variety of small ships with the destroyer heading the list for size and including

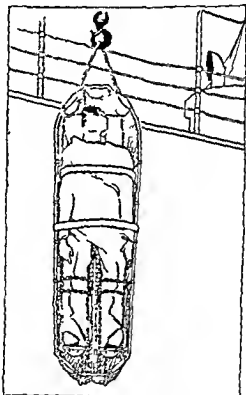


Fig 359—The Stokes net (U S Navy Medical Bulletin)

submarines mine sweepers submarine chaser motor torpedo boats and sea going tugs

make disposition of the case. If the medical officer is not available the *Pharmacist's Mate* arranges to have the patient transferred to a larger vessel in the vicinity or to a shore station. The pharmacist's mates assigned to such small vessels are well trained, capable and competent men, usually with ten or more

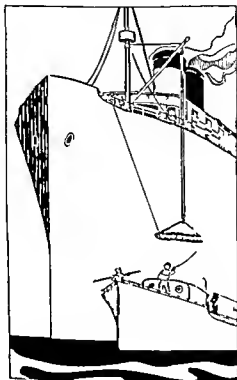


Fig. 36.—The Pharmacist's Mate transferring patient aboard ship from small boat.  
(U. S. N. I. Med. I. B. II. t.)

years of Naval service and in the event of inability to transfer the patient to a larger ship or to a shore station can do a very creditable piece of work, often displaying marked ingenuity in extemporizing gear from such material as may be available on the ship.

**Large Ships.**—In this category may be placed battleships



space called the sick bay is provided on each ship carrying medical personnel but on small vessels it is never adequate for more than the temporary treatment of the sick.

*Management of Fractures*—Should an accident result in a fracture occur aboard a small ship the immediate treatment



Fig. 361—The Sick Bay of the U. S. S. Albatross (L. S. A. 116) (L. S. A. 116)

of the case will consist of immobilizing the injured patient with temporary splints using basswood, the ever-present Thomas splint or any suitable material found on board, hip allaying pain and making the patient comfortable until the division medical officer arrives to determine the exact extent of the injury and

so that the patient is made ambulatory and able to carry on with at least a portion of his duties

Both aboard ship and in our Naval hospitals wide use is made of the *walking iron* cast in the treatment of distal lower extremity fractures. Most of these irons are constructed locally and display an interesting variety of construction. In the one

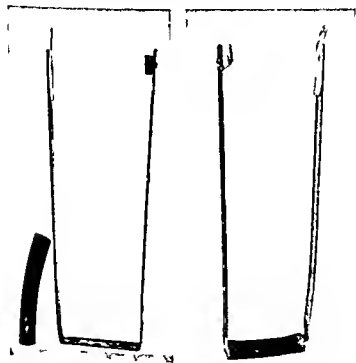


Fig. 363 and 364—Types of walking iron

illustrated (Fig. 363-365) the short cross piece on the top of a side bar is secured by one rivet so that it can be rotated to permit slipping over it a suitable length of old garden hose which when worked over the footpiece makes a handy springy and durable rubber cushion which can be easily renewed for use on another patient. On the eye of extension

aircraft carriers light and heavy cruisers and the ships of the train such as tenders transports supply ships and repair ships

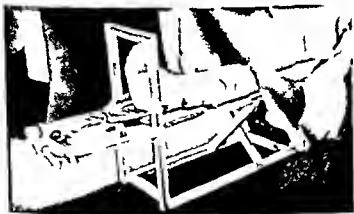
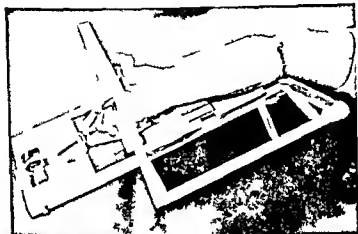
*Medical Personnel*—On these vessels the Medical Department consists of one or more medical officers a dental officer and several (from six to twenty) enlisted men of the Hospital Corps of various ratings Thus there is available a well organized medical unit providing for a division of work and for battle dressing stations located below armored decks which are manned prior to and during an actual engagement

*Equipment*—The equipment of a large ship consists of a sick bay which varies in size from 12 bunks on the older light cruisers to twenty or more on a battleship or aircraft carrier This sick bay is used in peacetime or when engagements at sea are unlikely as is a hospital ward It is equipped with comfortable bunks usually arranged in two tiers and in the newer vessels has one or more surgical type beds secured to the deck Adequate lighting and ventilation are provided together with lockers for bed linen blankets and ingeniously designed food trays which secure to the bunks and provide the maximum utility in a seaway Storerooms for medicinal agents surgical supplies and plants a small pharmacy and laboratory an operating room with instruments and sterilizers an office and examining room a dental office with full equipment an x-ray outfit together with the emergency battle dressing station constitute in general the Medical Department's equipment on board major ships

Under ordinary conditions most of the above mentioned ships can act as independent units as regards the care and treatment of their sick and injured

*Minor Fractures*—When a fracture occurs the patient is transported from any part of the ship to the sick bay Here he is examined and necessary x-rays are made Minor fractures involving phalanges metacarpals carpals and distal forearm are reduced under local anesthesia immobilized usually in plaster and the patient is returned to his duty under observation Similarly fractures involving the foot and ankle are reduced immobilized in a plaster boot with a walking iron incorporated

Illustrative of what may be done on board ship is the *leg splint* shown in the accompanying photographs (Figs 366 and 367) which was made on one of the aircraft carriers for the treatment of a fracture of the lower thirds of the tibia and fibula



Figs 366 and 367—Fitting of leg splint on board aircraft carrier

Sponge rubber was used for a leg and thigh cradle and at first traction applied by a Kirschner wire through the os calcis and attached to a standard turrup was maintained by weight

maneuvers the Executive Officer of a cruiser sustained a fracture of the distal end of the tibia. The fracture was reduced, a plaster boot with walking iron applied, and on the following day the patient was able to resume his duties much to his satisfaction and to the relief of his Commanding Officer.

*Major Fractures*—In major fractures occurring aboard large ships, definitive treatment is carried out when necessary but

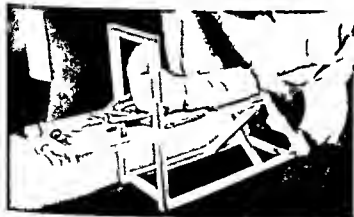
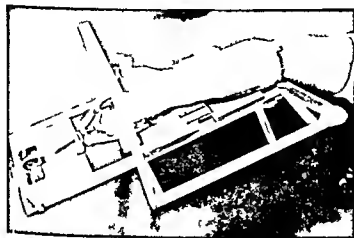


Fig. 365—Walking iron

when convalescence is to be protracted the patient is usually well prepared for transportation and at the first opportunity evacuated to a hospital or hospital ship.

*Improved Equipment*—A large ship is well provided with shops and mechanical technicians; many extemporaneously constructed splints and other apparatus can be manufactured at the suggestion and under the direction of the medical officer.

Illustrative of what may be done on board ship is the *leg splint* shown in the accompanying photographs (Figs 366 and 367) which was made on one of the aircraft carriers for the treatment of a fracture of the lower thirds of the tibia and fibula



Figs 366-367. — Leg splint made on board ship for the treatment of a fracture of the lower thirds of the tibia and fibula.

Sponge rubber was used for a leg and thigh cradle and at first traction applied by a Kirschner wire through the os calcis and attached to a standard stirrup was maintained by weight

these latter resting in an upright casing to prevent pendulum action from the motion of the ship at sea. Later the weights were discontinued and traction was maintained by an elastic cord the amount of traction being measured by a spring balance. After reduction was secured and a cast applied traction in this device was continued to provide a steady factor against the ship's motion and to promote the comfort of the patient until he could be transferred to a hospital ashore for the completion of his convalescence. The variety of such devices and their effectiveness in treating fractures aboard ship is limited only by the ingenuity of the medical officer and his assistants.

*First Aid during Engagements*—In wartime since regulations governing watertight and fumetight integrity of compartments are rigidly enforced not only during actual engagement but also during period when conditions of readiness for action must be maintained the medical department is completely isolated and can render no direct immediate aid to the ship's company during such period. The care of fractures and other casualties during the above phases is provided for by

- 1 Careful thorough preparation and instruction of all hand in fundamental first aid measures

- 2 A competent first aid team to every damage control party which when occasion arises will render aid to the injured in any compartment visited

- 3 Distribution of first aid kits to all battle stations

*Battle Dressing Stations*—During hull in battle or when an engagement is finished casualties are promptly collected to battle dressing stations using a stretcher bearers certain members of the crew especially trained for this purpose. At these stations treatment and prompt return to duty of the men suffering minor injuries are accomplished. Emergency measures of stopping hemorrhage immobilizing fractures allaying pain and treating shock are provided for major injuries. Later depending on existing circumstances these patients are given such definite treatment as is possible or are evacuated to a hospital ship or shore hospital.

**Hospital Ships**—There are several types of ships devoted to the care or transportation of the sick and injured—the fleet

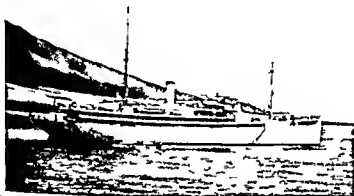


Fig 368—Fleet hospital USS Rhea (C-12) (U.S.N. Medical Ship)

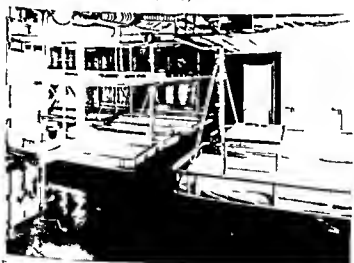


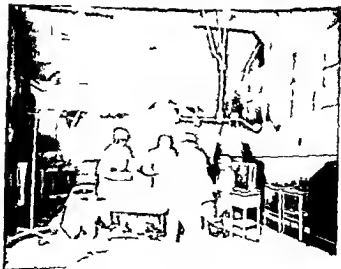
Fig 369—Deck of USS Rhea (C-12) (U.S.N. Medical Ship)

hospital ship floating hospital for advanced bases hospital transports and reserve ships





F 30 Typical ward in SSSR (Courtesy of US Naval Medical School)



F 371 Men in ward in USSR (Courtesy of US Naval Medical School)

*Facilities of the Fleet Hospital Ship*—The fleet hospital ship is especially constructed for its intended function which is to accompany the fleet and to provide it with full hospital facilities. The size is ordinarily 8 000 to 10 000 tons—large ships are uneconomical—the bed capacity 400 to 500 and the divi-

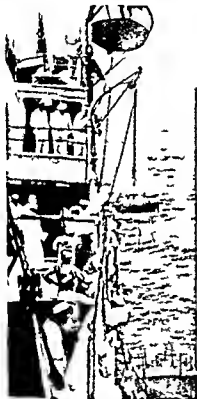
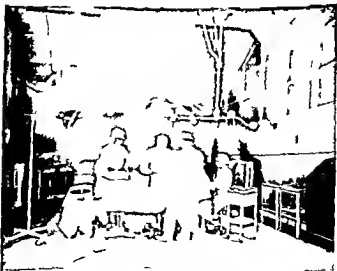


Fig 372—B s s p t t b d U S S R l f t e (C r t y f  
U S N I M d I B H t V I 36)

sion of space devoted to hospital use is in accordance with the usual expectancy as regard classification of patients. All the usual facilities of a hospital ashore are to be found aboard including a well equipped operating unit a laboratory x ray eye ear nose and throat and dental departments facilities



F 30-Splad USSRbf (C ty IUS N al Medical  
Sh 1)



F 31-Mm pers m USSRbf (C rt sy IUS N al  
M dical School)

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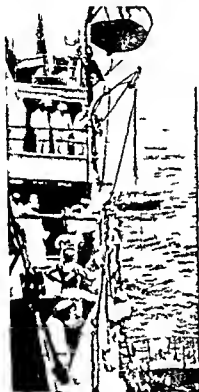


Fig 372—B g p t t b d U S S R i f t (C t y l  
U S N 1 M d 1 B H t V 1 36)

sion of space devoted to hospital use is in accordance with the usual expectancy as regards classification of patients. All the usual facilities of a hospital ashore are to be found aboard including a well equipped operating unit a laboratory x ray eye ear nose and throat and dental departments facilities

for special clinical examinations as well as medical surgical urological and contagious wards. For economy of space on the ship bunks in stead of bed are employed. The e are wide com



F 373—C long h ing d (C t f U S N val Med cal  
S h 1)

fortable well secured to bulkheads or stanchions and may should need arise be double de ked (F 368-371)

To facilitate landi n<sub>g</sub> of the si k and injured the ho p tal

ship has wide gangways entry ports in the hull and a plentiful supply of boats and cranes especially designed for hoisting in patients (Figs 372 and 373)

One of our hospital ships the U S S Relief serving a large fleet personnel during a typical year had 202 admissions for fractures classified as given in Table 3

TABLE 3

I cm	ce	v	F	ct	T	U S S RELIEF				URIN
			PER		O	YEAR				
			I J	d	I J	d m	I J	d	M	T t l
			Sh p	d	Abt t	by	M t	l		
			B	ts	C	t t	V h l			
bl	dubl		10		3		7	16		36
M xll	d f	ial b	2		1		4	1		8
Cl	!		1		4		8	1		14
Scap	!		0		0		3	0		3
H m	u		0		0		5	0		5
F	m		5		0		7	2		14
Wrist			2		2		3	0		7
M ta	p l	d h d	21		0		2	0		23
Rib			3		2		3	1		9
Sp			4		0		4	0		8
P l			2		0		4	1		7
P m			1		0		5	0		6
P t il			1		0		1	0		2
T b	d fib	!	5		0		15	1		21
Ankl			4		5		7	2		18
T					0		3	0		7
M t t rsal			11		0		3	0		14
T t l			77		17		83	25		202

*Skeletal Traction*—When skeletal traction is employed as it is necessarily at times one problem aboard ship not found ashore is the prevention of pendulum action of the weights. This is met by running the cord holding the weights through a pipe or tube or by substituting elastic cord for the weights. In either case the motion of the ship does not then influence the maintenance of steady constant traction in the desired plane.

*Protracted Dislocations*—While definitive treatment of frac

tures is given aboard hospital ship and patients for the most part are retained until able to be returned to duty the protracted nature of some disabilities requires that these latter patients be transferred to hospital ashore for further convalescence rehabilitation or for separation from the service Whenever the hospital ship undergoes a navy yard overhaul of necessity all patients must be transferred to a hospital ashore

*Warlike Functions*—In time of war the functions of the fleet hospital ship can be expected to be considerably expanded Not only will she provide hospital facilities while vessel remain in port but when the fleet or an expeditionary force goes to establish an advanced base she will accompany them When the fleet moves on the hospital ship accompanies the train and leaves behind in field hospital ashore those unable to resume duty in a short time or transfers such patients to hospital transports for return to permanent Naval hospitals

#### THE MANAGEMENT OF FRACTURES IN NAVAL HOSPITALS

Our Naval hospitals are equipped to care for major trauma and fractures of all types the extent and variety of particular fracture equipment depending somewhat upon the size of the hospital The capacity of Naval hospitals runs all the way from 200 or 300 beds to more than 1500

*Convalescent Period*—The management of fractures in these hospital is like that in similarly equipped civil institutions but is modified somewhat by circumstances peculiar to Naval requirements and administration As the enlisted man has at least theoretically no home or similar place where he may spend the convalescent period following definitive treatment of his trauma he is retained in the hospital until able to return to his ordinary duty aboard ship He spends this period performing such work as his condition permits A patient confined to bed with the lower extremity trauma can fold gauze or assemble splint cups one with a lower leg fracture ambulant in a walking cast can operate a deck polisher machine or wash off bedside locker tops a man with one upper

extremity in a plaster dressing can dust ward furniture or act as a messenger. There is a multitude of minor chores that men can do and which serve to occupy their time to useful purpose. Later in the rehabilitation stage the early return of function in the injured limb is facilitated by assigning men to carefully elected minor duties and by increasing their activity until they are able to resume their regular work.

Men whose trauma results in some permanent residual deformity are not returned to duty as frequently as in civil life. As the modern Navy is highly mechanized and intricately organized a man with a stiff elbow for instance returning to a high speed machine is considered not only more liable to further injury to himself but might well be the cause of serious injury to others and at the same time produce a mechanical casualty at a critical moment. Such men are usually invalided from the service.

**Modern Trends in Treatment**—One of the major trends in fracture treatment in Naval hospitals is toward the wider use of *ambulatory methods*. The reasons for this trend are obvious. Another is the increased employment of *local anesthesia* in reduction. Elaborate methods of anesthesia are usually impracticable and not available aboard ship and in the field. A surgeon adept in the use of local anesthesia has a great advantage under such circumstances and as all Naval medical officers do duty at one time or another on ships and under field conditions the place for them to perfect themselves in anesthesia technique is in our hospitals. In this connection the use of *intravenous anesthesia* is rapidly widening. It is apparently safe and efficient and under service conditions possesses two important characteristics: (1) it is nonexplosive and (2) it can be administered with a minimum of sterile equipment.

A third notable trend is in the increasing number of *open reductions* where the fragments are secured by vitalium plates, screws or nail. In a fracture which cannot be easily reduced and maintained in reduction by ordinary method of traction and manipulation or by one of the more commonly used mechanical reduction devices employing multiple transfixion by



pins or wires early open reduction is done. Vitallium has been used by us even in the presence of gross contamination with satisfactory results. Most Naval hospitals are equipped with some mechanical reduction device employing pins or wires which are later incorporated in plaster casts. In properly selected cases these devices have proved satisfactory and their use is often an important factor in securing an early ambulatory status in fractures of the lower extremity.

To our Naval hospitals also come the men whose trauma has been of necessity treated elsewhere on board ship or at advanced bases and who sometimes require a revision of their previous treatment. In cases where *malposition* has resulted revision usually consists of open reduction and securing of fragments by suitable vitallium fixation. No union formerly treated by bone graft alone is especially in cases involving a major long bone frequently handled by bone graft plus fixation by vitallium.

Naval hospitals are also equipped with effective *physical therapy* installations with trained personnel to administer treatments. In the rehabilitation phase of the treatment of major fractures extensive use of physical therapy is routinely made and is considered of value in facilitating the early return to duty of these patients.

Medical officers of the Navy afloat and ashore are keenly aware of both the opportunities and the responsibilities in the care and treatment of fractures and are endeavoring to conscientiously and successfully fulfill the mission of their Corps.

To keep as many men at as many guns as many days as possible.

## MANAGEMENT OF WOUNDS

FREDERICK R. HOOK, M.D., F.A.C.S.

C. M. CAL. C. HPS. U. ED. S. ES. N. CHIEF. S. S.  
UNITED S. ES. N. AL. H. A. WASHIN. N. D. C.

The large number of industrial and traffic accidents that occur in this country has given our surgeons considerable experience in the treatment of contaminated wound. The lessons learned from this experience can be applied to the treatment of war wounds if we keep in mind the following facts: (1) In modern warfare a large percentage of the wounds are due to bombs, multiple wounds being extremely common. (2) These wounds are associated with severe shock, extensive tissue disruption and early virulent infection. (3) High explosive fragments, owing to their ragged nature, even though small, do more damage to the soft tissue than do machine gun bullets, and almost invariably carry foreign matter such as pieces of clothing, masonry, pocket articles and so forth into the tissues, thus favoring infection.

There are four general principles that influence the treatment of war wounds: (1) the character of the soil on which the fighting takes place; (2) the time of the year; (3) the type of projectile; (4) the character of the military operation.

### CLASSIFICATION OF WAR WOUNDS

Many classifications of war wounds have been formulated, that of Basil Hughes is descriptive, comprehensive and adequate. It is as follows: (1) nonpenetrating wounds; (2) penetrating (lodging) wound; (3) perforating wound; (4) dis-

The purpose of this study is to determine the effect of the Department of the Army on the management of war wounds. The study is based on a review of the literature and a survey of the Department of the Army's policies and procedures. The study is intended to provide a basis for the development of a comprehensive and adequate classification of war wounds.

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To keep as many men at as many guns as many days as possible

tive treatment This may not be necessary however in bullet wounds with small entrances and exits without swelling of the intervening tissues and in multiple superficial wounds due to pepperin<sup>g</sup> with tiny fragments of low velocity such as those from hand grenades Bomb fragments do not fall under this category as they have a high velocity and although they frequently do produce pepperin<sup>g</sup> of the surface tissues small fragments may produce severe damage by penetrating the deeper structures

*Gutter wounds* are the easiest type to excise for the entire track is under vision *Penetrating wounds* contain foreign bodies includin<sup>g</sup> bits of clothing blood clots and so forth these must be taken away with the wall of the track and to make this possible adequate exposure is essential Every crevice must be explored and all hematomas opened up *Perforating wounds* of the tunnel variety of approximately the same dimensions throu<sup>g</sup>hout their length may be handled by tubular excision If the deeper parts of the wound are of greater dimensions than those nearer the surface excision of the track becomes more difficult It is important not to cause additional trauma and intact skin and muscle should not be ruthlessly divided in order to join wounds of entrance and exit

**Preparation for Operation**—Routine wound excision under battle conditions requires a maximum amount of team work Although it is highly desirable that these patients reach the operating theater at the earliest possible time they should not be transported until shock has been brought under control and until x ray examination has been made of wounds in which foreign bodies are lodged The selection and preparation of cases for operation will usually have to be done by someone other than the surgeon and each surgical team to conserve time should have two operating tables Many victims of head neck and trunk wound die before reaching the hospital Because of this fact about two thirds of the wounds of the patients arriving at hospital alive are located in the extremities An orthopedic type of operating table therefore is desirable since it gives support to the limb during operation

ruptive (blast) wounds (5) incised and stab wounds (6) burns (7) asphyxiation and gas poisoning (8) accidental wounds

#### CHANGES OCCURRING IN WOUNDED TISSUE

Hughes describes three changes that occur in wounded tissue. These are (1) disruption (2) reactionary edema and (3) visible infection. The amount of disruption depends upon the velocity of the missile and is at its greatest in penetrating or lodging wounds. Disruption of muscles results in their fasciculi being forced apart and deprived of their blood supply. It frequently extends over a considerable distance from the wound and the tissues so affected make an excellent medium for anaerobic infection. Reactionary edema soon follows disruption. There is outpouring of lymph into the spaces formed in the disrupted tissue so that the parts swell. In the case of disrupted muscles of a limb tension beneath the deep fascia may become so great as to jeopardize the circulation. The tissues at this time are contaminated but as yet not visibly infected. The interval between contamination and the appearance of evidences of infection is commonly known as the time lag. In a matter of hours the stage of reactionary edema passes imperceptibly into that of visible infection. The swelling increases to such an extent that frequently edematous muscle will be seen protruding from the wound. This protrusion produces a stopper effect in an opening which is inadequate already and further impedes the escape of inflammatory products.

#### EXCISION OF WOUNDS

**Principles of Wound Excision**—A wound is considered recent from the inception until signs of inflammation develop. These usually appear within twenty-four hours. The principle of wound excision demands that (1) positive treatment be instituted before evidence of inflammation appears (2) the tissues lining the wound track be adequately excised and (3) immobilization of the injured part be maintained in order to give complete rest.

The great majority of projectile wounds will require opera-

tive treatment This may not be necessary however in bullet wounds with small entrances and exits without swelling of the intervening tissues and in multiple superficial wounds due to pepperin<sup>g</sup> with tiny fragments of low velocity such as those from hand grenades Bomb fragments do not fall under this category as they have a high velocity and although they frequently do produce pepperin<sup>g</sup> of the surface tissues small fragments may produce severe damage by penetrating the deeper structures

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These patients who have wounds in the limbs do not stand surgery well and any procedure attempted should be accomplished as expeditiously as possible. With this fact in mind it may be necessary for the surgeon to treat only the most serious of a patient's wound and at times a rapid amputation may be a life saving measure in cases in which a prolonged operation might be more than the patient could survive. Ordinarily the only indication for amputation is a destruction of the blood supply to the limb occasionally however it will be necessary to do an emergency amputation of a limb caught in machinery or under fallen masonry. Tourniquets should not be used except when amputations are being done and it is necessary to control rapid loss of blood. Statistics show that 80 per cent of limbs on which tourniquets have been applied for three hours have come to amputation. Jolly states that there are more limbs and lives lost at the front from the improper use of the tourniquet than are saved by its proper use.

**Technic of Wound Excision.**—The limb must be prepared well above and below the wound and around the entire circumference of the limb. This preparation may be made in the usual manner by the use of either iodine and alcohol or any of the other commonly used skin antiseptics or it may be made by scrubbing with large amounts of tincture of green soap and water. The wound itself should be protected from further contamination during this procedure. Bigard and Baker protect it by temporarily closing the wound with Michel clips. They have shown by animal experimentation that tincture of green soap washings in wound definitely delays wound healing. After the skin has been prepared the skin edges of the wound are excised care being taken not to sacrifice any more of the skin than is absolutely necessary. Adequate longitudinal incisions should be made so that every part of the wound comes under direct vision without marked retraction of the tissues. The wall of the track should be picked up with toothed forceps and complete excision of the track done with a sharp knife. Injury to important vessels and nerves should be avoided. Foreign

bodies should not be removed through separate incisions but should be reached by following the wound track.

Aponeurosis tendon and bone are resistant to the invasion of bacteria and can survive in spite of a poor blood supply. It is desirable to remove completely detached fragments of bone but if there are any attachments to periosteum it is advisable to leave them particularly if they are needed to provide continuity of bone.

*Damaged Muscle Tissue*—Much of the surgeon's time will be taken up by the attention he must give to the damaged muscle tissue. If the muscle bleeds on section it is safe to leave. If it is brick red in color and does not bleed easily or contract when pinched anaerobic infection is present and the whole muscle or group of muscles may have to be sacrificed. If the muscle's blood supply has been destroyed above and below the wound the muscle must be removed up to its attachment to bone or tendon in order to prevent necrosis and infection. When a muscle is completely divided the portions retract. They must be followed up and the damaged tissue removed from them even though marked enlargement of the wound is necessitated. Nerves that are severed should be brought into apposition if this can be done without tension otherwise they should be left for another occasion. Meticulous hemostasis is important. Individual vessels should be ligated with fine catgut sutures with as little tissue as possible included in the ligature.

#### MANAGEMENT OF WOUNDS AFTER EXCISION

What shall we do with the wound after excision has been completed? The two great principles which have emerged from the modern treatment of wounds by excision are (1) tissue support is needed to prevent or control edema and (2) immobilization is needed to give complete rest to the injured part. If the surgeon will observe these principles he will not be confused by the diversity of methods that have been described for handling of wounds after excision has been completed.

*Primary Suture*—There is ample evidence that primary suture is a safe and correct procedure in civil practice. In war



These patients who have wounds in the limbs do not stand surgery well and any procedure attempted should be accomplished as expeditiously as possible. With this fact in mind it may be necessary for the surgeon to treat only the most serious of a patient's wounds and at times a rapid amputation may be a life saving measure in cases in which a prolonged operation might be more than the patient could survive. Ordinarily the only indication for amputation is a destruction of the blood supply to the limb; occasionally, however, it will be necessary to do an emergency amputation of a limb caught in machinery or under fallen masonry. *Tourniquets* should not be used except when amputations are being done and it is necessary to control rapid loss of blood. Statistics show that 80 per cent of limbs on which tourniquets have been applied for three hours have come to amputation. Jolly states that there are more limbs and lives lost at the front from the improper use of the tourniquet than are saved by its proper use.

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surgery it is probably safe if the excision has been performed early is complete and aseptic. If the wound is sutured four conditions must be met: (1) there must be no buried sutures put in the wound to close dead spaces; (2) the skin edges must close without tension; (3) drainage tubes must not be left in the wound; and (4) the patient must remain under the care of the surgeon doing the work. What has just been said does not apply to war wounds of the hand, face, scalp, thorax and abdominal cavity as according to routine they are closed by primary suture.

**Packing the Wound**—Packing the wound gives excellent support to the tissues from within as the pack replaces the bulk of tissue removed. This packing may be done with dry gauze (Trueta), vaseline gauze (Orr) or with cod liver oil gauze (Odelberg). Gurd and McKim report excellent results when the wound is packed with bismuth iodoform and paraffin paste (bipp). It is important that every crevice of the wound be packed if the best results are to be had.

**Closed Plaster Method of Treatment**—The closed plaster method of treatment was popularized by Trueta in the recent Spanish war. It is based upon the Orr method of treatment of osteomyelitis and the Bohler treatment of fractures. After thorough wound excision either followed by primary suture or wound packing, an accurately molded plaster case is applied to the skin with padding only over the bony prominences. The case must immobilize the joints above and below the injury; it must never be padded and windows must never be cut in it since edema will occur at the site of the cut-out and defeat the purpose of the treatment. Changes in the plaster should be made only when it becomes soft or offensive as some toxemia develops with each change. Every two to five weeks usually is sufficient. It is important that elevation of the part be maintained in the closed plaster treatment since elevation tends to diminish the edema and preserve the circulation. To insure the safety of this method of treatment wound excision must be complete and it must be carried out within six to eight hours after injury. The blood supply of the limb must not be in doubt.

Trueta reported a surprisingly small number of cases of streptococcal septicemia and gas gangrene from this method of treatment. British surgeons also have used the method with gratifying results but are of the opinion that it is still on trial.

**Carrel Dakin Treatment**—The Carrel Dakin treatment may be advisable in those cases in which wound excision has been incomplete. This treatment fails to provide both tissue support and appropriate immobilization of the injured part but has the advantage of encouraging wound drainage. It may be used when it is known that dead tissue will have to separate. It has the disadvantage of requiring a maximal amount of supervision if it is to be successful. In the present war it will probably be a method of treatment of necessity rather than of choice as was the case during the latter part of World War I.

### INTERNAL FIXATION OF FRACTURES

About 60 per cent of all war wounds are compound fractures. For this reason every surgeon caring for war wounds should have a good working knowledge of the management of fractures. By meticulous wound excision many of our surgeons in civil practice have been able to use internal fixation in compound contaminated fractures with excellent results. Undoubtedly they could use it successfully in selected war wounds. The question is, however, would it be advisable to recommend it for general use? The answer at the present time must be no.

If the immobilization afforded by a nonpadded casing is not satisfactory, skeletal traction may be used by the insertion of pins above and below the fracture. They are embedded in the plaster or attached to the lateral bars of a Thomas splint. Better still are the methods of Haines and of Roger Anderson in which dual screws or half pins inserted into the bone above and below the fracture site are made to hold the fragments in alignment by a rigid external bar. This bar not only gives firm fixation but allows the application of plaster to the skin thereby giving support to the tissues. These methods of treatment make it possible to change the casing without disturbing the position of the fracture. They would appear to have their

greatest application in patients in whom there has been marked comminution of bone accompanied by loss of substance as they will prevent shortening of the member and malposition of the fragments during the long healing period

### INFECTED WOUNDS

Unfortunately battle conditions are such that many wounds are not seen by a surgeon competent or equipped to carry out the correct definitive treatment until visible infection is established. During the period of contamination organisms multiply in the tissues but invasion of the lymphatics does not yet occur. It is during this period that excision can be done with safety. This period may be as long as twelve hours but it is possible that the hemolytic streptococcus may pass beyond the barrier within six hours. The clinical appearance of the patient and the circumstance of the wound must be the deciding factor in determining period of safety of excision.

As infection succeeds contamination micro-organisms have extended beyond the wound track toxins are being absorbed and the patient becomes ill. Wound excision at this time not only will be useless but will be a dangerous procedure. Many of the patients seen in this condition will be treated by wound dressing. Any active surgical intervention must be purposeful and well planned. Indications may arise that call for incision for drainage removal of foreign bodies or the control of secondary hemorrhage. To prevent breaking down of the natural barriers accompanied by release of toxins and organisms into the circulation extreme gentleness should be observed in handling the limb.

**Clinical Signs of Infection**—By the second or third day definite signs of inflammation will be present. Many of the patients will have suffered for hours or days from hunger pain and exposure when seen at this time unless there is definite evidence of anaerobic infection it may be best to allow them food rest and sleep before decision on any surgical procedure is made. This period of observation and rest will not only put the patients in better condition to withstand surgery but it will

make surgery unnecessary in some of them. If when seen late the patient is comparatively comfortable and there is little edema or tenderness along the track of the missile or no discharge from the depth of the wound the wound should be let alone. If there is tenderness along the wound track or about the wound the surgeon should be suspicious of deep infection. Radiographs should be made to show whether foreign body and gas bubbles are present. Pain and a sense of tension in the limb while at rest are distinct danger signals frequently pointing to anaerobic infection. Increase in pain and swelling two or three days after a severe bruise wound may mean a deep seated infection of extravasated blood. A thin offensive bloody discharge and a spreading mottled bronzing discoloration of the surrounding skin are indicative of anaerobic infection and debridement must be done. A rising pulse rate with pain in and about the wound, a subnormal temperature or a sudden rise to 103° or 104° F are danger signals that point toward gas gangrene infection.

**Wounds Containing Debris**—In penetrating wound where a large jagged missile has probably carried bits of clothing and other debris into the wound x ray localization and immediate removal are indicated. This removal is accomplished by free incision in longitudinal directions when possible debridement (not excision) as well as careful and gentle examination of all parts of the wound. If the fragment is found in damaged muscle this muscle should be excised because of the probable development of gas gangrene. The wound should have free and easy drainage from all parts.

**Wounds Complicated by Fractures**—The dangers of sepsis are much greater in wounds that are complicated by

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fractures of long bones. There is frequently marked disruption of the soft tissues by the bone fragments. Such cases will almost always require debridement. Free incision must be made to explore the depth of the wound. Foreign bodies including the pieces of bone must be removed. If there is alteration of the color or consistency of the muscle or if it fails to bleed when cut, it must be cut away until normal muscle is encountered. Gas gangrene is primarily a disease of disturbed circulation. If gas gangrene is already established it may be necessary to excise the entire muscle or group of muscles. After bleeding has been controlled and free drainage established to every crevice of the wound, it may then be packed with vaseline gauze and a nonpadded plaster casing applied. The Haines and the Roer Anderson methods of plating are especially indicated in this type of fracture as they give better immobilization than other method and they permit changing of the casing and dressing of the wound without disarrangement of the fracture alignment.

In general the following rules hold true in the treatment of infected fractures: (1) Dressings should be applied as infrequently as possible. (2) Strong chemical antiseptics are definitely harmful and interfere with wound healing. Dakin's solution probably has its greatest use in deep infected wound in which debridement has been done. (3) The closed plaster method achieves complete rest for the limb; it prevents interference with the wound and it permits free escape of pus and excretions.

**Serums**—Until our troops are actively immunized against tetanus with tetanus toxoid, it will be necessary to use prophylactic doses of tetanus antitoxin in the presence of all war wound. Surgeons serving in the last war found it advisable to repeat the injection in the severely wounded and following surgery at later dates. Prophylactic doses of anti gas gangrene serum should be used in all wounds in which there has been considerable muscle damage; this is especially true for wound of the lower extremities and the buttocks. Anti gas gangrene serum should also be given as a curative measure after the disease is established.

**Radiation Therapy**—As to the value of radiation therapy in the treatment of gas gangrene infection there is considerable difference of opinion Kelly has reported excellent results with its use while Caldwell feels that it is of no particular value

### CHEMOTHERAPY IN WAR WOUNDS

It is too early at this time to prophesy just what place the sulfa drugs will eventually occupy in the treatment of war wounds With the many excellent papers being published on the treatment of contaminated wounds in civil practice with these drugs and the large amount of animal experimentation that has been done both in this country and abroad on simulated war wounds it is believed that the following conclusions are warranted

- 1 The *sulfonamides* have opened up an entirely new approach to the treatment of war wounds
- 2 Although they show promise in the treatment of established infection their greatest use will probably be in the prevention or lessening of intensity of infection If they do nothing more than prolong the period in which wound excision can be done with safety they will prove to be of inestimable value
- 3 *Local application* of the drugs is superior to their use orally since 75 to 100 times the concentration can be had in the tissue about the wound as can be produced by oral administration No safe dose by mouth can give as high a local concentration as a moderate sized dose locally
- 4 In a powdered form these drugs used locally are bacteriostatic and bacteriocidal (at least for some micro organisms) They produce little tissue reaction and unless used in excessive quantities interfere very little with wound healing The average dose in a wound should be about 0.1 gm per square inch of wound surface
- 5 *Sulfanilamide* is rapidly absorbed from the peritoneum (Jackson) the blood concentration peak occurring between the second and third hour after implantation It takes twenty-four hours to get the peak concentration when administered



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ment from the air. The mortality rate of burns varies with the areas of the body burned and it is the surface extent of the burn rather than its depth that endangers life. A burn covering more than a quarter of the body surface is always a serious threat to life. In the past the mistake has been made frequently of neglecting the patient's general condition while treating the local lesion. This error has resulted in the development of a state of irreversible shock.

**Pathology**—Deaths from burns fall under four categories.

1 *Primary Shock*—Primary shock accounts for only 2 to 3 per cent of burn deaths. It occurs shortly after the injury and is somewhat similar to a syncopal attack. It may be based on a psychological factor and is usually seen in patients who have been rescued from burning buildings. It responds readily to relief from pain, warmth, reassurance and similar measures.

2 *Secondary Shock*—Secondary shock accounts for 60 to 80 per cent of deaths from burns. It develops rapidly, being manifest within two hours after injury. There is still considerable dispute about the pathological physiology that brings about burn shock. There seems to be little doubt that the fluid imbalance seen in severe burns is due primarily to an altered capillary permeability with a shift of the fluid protein into the tissues rather than an external loss. A burn of one sixth of the body surface may result in the loss of over 70 per cent of the total volume. Associated with this loss is marked hemoconcentration.

3 *Toxemia*—Toxemia occurs from two to ten days after the injury. It is caused by flooding of the liver with toxins absorbed from the damaged tissue cells and from septic absorption from the wound. Adequate amounts of glucose should be given to protect the liver.

4 *Scarring*—Scarring occurs as a rule only in the deep burns and is preventable primarily by proper care of the wound and by early grafting of skin.

**Treatment**—Three objectives should be kept in mind in the treatment of burns. (1) prevention and control of shock. (2)

orally. The dose *intra-peritoneally* should be about 175 m per kilogram of body weight and should never exceed 12 to 15 gm.

6 As a prophylactic agent sulfanilamide should be used locally and orally in all contaminated wounds. The primary oral dose should be twice the maintenance dose.

7 After infection is established and especially if staphylococci and anaerobes are found in the wound *sulfathiazole* should be used locally and orally or the two drugs may be used together. A study of the bacteriology of the wound will help the surgeon to outline the treatment.

8 Because of vomiting or following wound or operations on the gastro intestinal tract sulfanilamide may be given by *hypodermoclysis* in 0.8 per cent concentration in normal saline solution. If it is given intravenously in the soluble salts a blood concentration peak can be reached within five minutes.

9 Sulfanilamide powder and tablet will probably be used to our troops for local and oral use *immediately after injury*. The swallowing of a few tablets will be a simple matter but the way in which the wounded man will get the powdered drug down into the depth of a perforating or penetrating wound when the wounds of entrance and exit are small is another problem.

10 The early reports on *sulfadiazine* (Long, Strauss and Peterson and Feinstein and associates) lead to the opinion that this new compound is superior to the other sulfa drugs in that it is less toxic, adequate blood concentration can be maintained with more ease than with the others and it has greater activity than they do against the streptococci, staphylococci, *Escherichia coli*, *Clostridium welchii* and *C. septicum*.

11 *Zinc peroxide* may be of use in the treatment of anaerobic infections.

12 Chemotherapy is not a substitute for adequate surgery; it is a valuable adjunct.

### BURNS

In the present war burns constitute a high percentage of the casualties seen not only in service personnel but also in civilian populations. This fact is due to the great increase in bombard

ment from the air. The mortality rate of burns varies with the areas of the body burned and it is the surface extent of the burn rather than its depth that endangers life. A burn covering more than a quarter of the body surface is always a serious threat to life. In the past the mistake has been made frequently of neglecting the patient's general condition while treating the local lesion. This error has resulted in the development of a state of irreversible shock.

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**Treatment**—Three objectives should be kept in mind in the treatment of burns. (1) prevention and control of shock. (2)

prevention of acute toxemia and sepsis and (3) prevention of scarring

**Burn Shock**—In all burns of any consequence prophylaxis of shock should be instituted when the patient is first seen unfortunately many patients will be in severe shock by the time they reach the hospital Morphine  $\frac{1}{4}$  grain should be given to control pain clothes should be cut away and artificial heat applied In management of the fluid replacement Lee Rhoads and Wolff have found that consecutive determinations of the hematocrit and plasma concentration in patients with extensive burns make it possible to estimate the probable loss of protein from the circulating plasma and to evaluate the ability of the vascular tree to retain added plasma at various times following the injury This abnormal capillary permeability continues for about forty hours By the use of adrenal cortical hormone they have been able to shorten this period by twelve to eighteen hours By means of a combination of adrenal cortical hormone and frequent or continuous plasma infusions under rigid laboratory control they have carried patients with as much as 65 per cent of the body surface burned through the period of fluid shift Oxygen administered by the Boothby mask is of value also

**Toxemia and Sepsis**—Toxemia and sepsis should be prevented by proper cleansing of the burned area and by early coagulation The wound should be sponged gently with saline solution it may be necessary to use ether or ether soap to remove grease Blistered and loose skin should be cut away This work should be done under general anesthesia pentothal sodium being an ideal agent The surface may then be coagulated with triple dye (gentian violet 1:400 brilliant green 1:400 flavine 1:1000) or tanning may be produced by tannic acid (5 per cent) alone or in combination with silver nitrate (10 per cent) There are strong advocates for each of the methods under war conditions when the time element is of great importance the tannic acid silver nitrate treatment has the advantage that it produces a good protective coagulum within a few minutes if tannic acid is sprayed on and silver nitrate

is then swabbed over the surface. If there is an associated soft tissue wound or fracture of the extremity plaster may be applied over the tanned area with safety and comfort to the patient.

Warning has come from England with regard to the use of tannic acid on burns of the *face* and *hands*. If it is used on the face the eyes must be protected. When it is used on the hands in deep burns the coagulum may contract to such an extent as to cut off the blood supply to the ends of the fingers and gangrene of the terminal phalanges results. On the face and hands flavine 1:1000 in cod liver oil, continuous hot saline packs, or an aqueous solution of 1 per cent gentian violet may be used.

Early *skin grafting* is necessary to prevent scarring from deep burns. By use of the Padgett dermatome enormous quantities of skin of any thickness desired can be obtained with ease.

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# PREVENTION AND TREATMENT OF INFECTIONS IN TRAUMATIC WOUNDS

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A GENERAL discussion of the problem of surgical infections of wounds must begin with a consideration of certain fundamental principles which may be said to apply broadly to infection in any region of the body. A clear understanding of these principles is essential in the intelligent prevention and treatment of infections.

When bacteria gain access to subcutaneous, submucous, or serous tissues, the organisms are either destroyed by the forces mobilized by the inflammatory reaction, or the organisms begin to multiply and produce the modifications in the inflammatory response which are characteristic of the different types of infection. Bacteria from soil, skin, clothing, or intestine which constitute the primary contaminants in traumatic wounds do not commence to multiply actively for several hours after they gain access to the wound. Great advantage may be taken of this fact by the institution of *chemotherapy* of a wounded individual at the earliest possible moment before the bacteria have started to multiply.

The character of the infection which develops will depend on the following factors: (1) the number and invasiveness of the contaminating bacteria; (2) the pathologic character of the inflammatory response of the host to the particular type of bacteria concerned; (3) the blood supply of the contaminated





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When bacteria gain access to subcutaneous submucous or serous tissues the organisms are either destroyed by the forces mobilized by the inflammatory reaction or the organisms begin to multiply and produce the modifications in the inflammatory response which are characteristic of the different types of infections. Bacteria from soil skin clothing or intestine which constitute the primary contaminants in traumatic wounds do not commence to multiply actively for several hours after they gain access to the wound. Great advantage may be taken of this fact by the institution of *chemotherapy* of a wounded individual at the earliest possible moment before the bacteria have started to multiply.

The *character of the infection* which develops will depend on the following factors (1) the number and invasiveness of the contaminating bacteria (2) the pathologic character of the inflammatory response of the host to the particular type of bacteria concerned (3) the blood supply of the contaminated

part and the amount of injured or devitalized tissue in the area. The *degree to which the infection extends* either locally or throughout the body will depend on the above factors and also on (4) the capacity of the immunity response of the individual and (5) whether or not local anatomic barriers are present which will tend to confine the infection within a certain plane or compartment. The physician cannot apply intelligent treatment to any infection without taking into consideration all of the above factors whether the treatment be surgical, chemotherapeutic, immunologic or a combination of these.

#### RATIONALE OF THERAPY IN WOUND INFECTIONS

**Surgical Therapy**—Surgery is employed in relation to infections for the following general purposes:

1 In *prophylaxis* to remove debris and devitalized tissue in order to minimize the number of bacteria and to leave the wound in the best condition possible for healing. Furthermore, the conditions for bacterial growth are not nearly so favorable in a wound comprising only tissues which are well supplied with blood. The digestive process by which devitalized tissue is spontaneously removed from a wound brings about the liberation into the wound of protein-split products which greatly encourage the survival and multiplication of all types of bacteria. It is well known that the spores of the gas-gangrene-producing organisms require such a wound environment in order to develop into virulent vegetative form.

2 In *treatment* of established infections in order to evacuate pus to remove necrotic tissue and by decompression to prevent the spread of exudate under tension along anatomical planes.

**Chemotherapy**—Chemotherapy with one of the sulphonamides for example is employed for the following general purposes:

1 In *prophylaxis* to limit the multiplication of contaminating bacteria in a fresh wound or destroy them.

2 In *treatment* of established infections to check the rapidity of growth of bacteria in the body tissues and fluid thereby

facilitating their destruction by the host and to protect the uninvolved tissues against the spread to them of the infection

**Immunological Treatment**—Immunological therapy in relation to wound infections is employed for the following purposes

1 In *prophylaxis* to provide the patient with neutralizing antibody against certain specific bacterial toxins such as tetanus toxin or the toxin of *Clostridium welchii*

2 In *treatment* to neutralize bacterial toxins or to augment the effectiveness of the antibacterial mechanisms of the host

In general measures to prevent surgical infections or to treat established infections will involve using a combination of these three types of specific therapy

In the next section I shall discuss the practical application of these considerations to the prevention of infections in traumatic wounds Finally some consideration will be given to the treatment of specific types of infections

#### PREVENTION OF INFECTION IN TRAUMATIC WOUNDS

**Sulfanilamide**—The oral administration of an initial dose of 4 to 6 gm of sulfanilamide followed by successive doses of 1 gm every four hours will supply the wound fluids with concentrations of sulfanilamide probably sufficient in the majority of cases to delay or prevent the rapid multiplication in the wound of the primary bacterial contaminants Although this treatment is not by itself sufficient to prevent wound infection it constitutes an important and practical first step Sulfanilamide is recommended at present for this type of prophylaxis because of the relatively low incidence of serious toxic complications attending its use It is not yet certain whether sulfanilamide may be supplanted by one of the newer sulfonamide drugs although the limited experience with sulfadiazine is encouraging

**Excision of the Wound**—The second step in the prevention of infections in traumatic wounds is wound excision or *débridement* This procedure involves the excision under general anesthesia of accessible foreign bodies of bits of clothing and other foreign material and of all tissues which have been

seriously crushed or otherwise separated from an adequate supply of blood. As a rule, no attempt should be made under emergency conditions to repair nerves and tendons, but fractures should be treated as would any open reduction, except that primary wound closure is not generally agreed on. Serious consequences may follow if damaged muscle which may become necrotic is left in the wound. The surgeon should be radical in his removal of this tissue, but he may adopt a more conservative policy in excising skin and subcutaneous tissue.

The entire procedure should be carried out with strict *aseptic precautions*. The surrounding skin should be widely prepared with soap and water, benzene and alcohol of 70 per cent (by weight) strength, and the patient and all attendants should be carefully masked. Special mention is made of these precautions because of the fact that many infections in traumatic wounds are probably due to pathogenic hemolytic streptococci and staphylococci transferred from the respiratory tracts and hands of the medical personnel at the time of operative treatment or postoperative dressing.

After wound excision has been completed and hemostasis is effected, the wound should be *irrigated* with a considerable volume of normal saline solution applied preferably in a fine stream under pressure through a small nozzle in order to further mechanical separation of bits of blood clot and debris.

The operative procedure so conducted will serve to remove most of the bacteria and foreign bodies from the wound and will provide conditions in the wound which will be unfavorable to bacterial multiplication. Still further protection against infection may be obtained by applying a thin layer of *powdered sulfanilamide* or *sulfathiazole* to the entire wound surface using approximately 1 gm. for each 10 square inches of wound surface. Care should be taken to avoid massive aggregations of the powder at any one point because such aggregation may lead to foreign body reaction. Not over 15 gm. of sulfanilamide should be applied to the wounds of any one patient because the drug is rapidly absorbed and may cause toxic effects if the quantity applied is too great.

The wound is then ready for closure if this is technically feasible and not more than six hours following injury have elapsed or for the application of some other type of dressing if closure is impractical.

**Wound Dressing and Immobilization**—Under emergency conditions demanding early transportation of individuals with wounds of the extremities the Orr Trueta method of treatment for such cases will be of especial usefulness. It involves packing the wound loosely with plain or vaseline gauze and then applying plaster of Paris directly to the skin with padding used only over bony prominences. The incidence of serious infections in wounds so treated is reported to be exceedingly low partly because the infrequency of dressings minimizes the secondary introduction of pathogenic bacteria and also because a well immobilized wound tends rapidly to form barriers against spreading infection.

When the conditions do not require early transportation of the patient and the facilities of a well equipped hospital are available the surgeon may choose to employ some other method of wound dressing and immobilization in order to permit better control of the fracture if such is present or secondary suture of the wound if no infection develops. In such cases *sulfanilamide* or *sulfathiazole* may be reapplied locally to the wound every forty eight hours and if no devitalized tissues are present the development of infection will be unlikely to occur. The administration of sulfanilamide by mouth 1 gm every four hours should be continued in all cases of serious injuries for about seven to ten days. By the end of that time the wound will probably be healed if successful primary closure was obtained or will be covered by protective granulation tissue if secondary healing is taking place.

**Other Preventive Measures**—Other considerations involved in the prevention of infection in traumatic wounds include the following:

1. *Tetanus antitoxin* 3000 units should be given after preliminary test of sensitivity accompanied by 1 cc of *tetanus toxoid* (to be repeated on the eighteenth and thirty ninth

days) However if the individual has already received a full course of toxoid immunization only 1 cc of toxoid need be given

2 *Gas gangrene antitoxin* should be given following wound which are probably contaminated with human or animal excreta such as wounds of the anal region

3 When sulfanilamide cannot be given by mouth it may be given *subcutaneously* The solution is prepared by dissolving 10 gm of sulfanilamide powder in 1000 cc of normal saline solution which has been previously brought to a boil The total dosage parenterally is the same as the total dosage by mouth but interval of six instead of four hours may be used

4 Sulfanilamide may be introduced for prophylactic purposes into the peritoneal or pleural cavities into joints or applied to the brain without interfering with wound healing However the local concentration will only remain in the effective range for about forty eight hours Hence it is important to supplement local treatment by oral administration

#### TREATMENT OF SPECIFIC TYPES OF WOUND INFECTIONS

In all surgical infections it is important to maintain immobilization with splint or massive dressing and when possible high elevation of the infected part Space will not permit further emphasis of these and other important therapeutic details such as good nursing care satisfaction of the fluid and nutritional requirements of the patient and the prevention or treatment of shock all of which are indispensable to good surgery of any type and are not restricted to the domain of surgical infections

**Hemolytic Streptococcal Infections**—*Source*—Droplets from the respiratory passages of medical attendants or of the patient himself are the chief source of infection Droplet infection may easily be carried in a ward directly from one infected wound to another

*Clinical Course*—The infection may start in trivial abrasions as well as in larger wounds The infection is characterized by the early development of signs of lymphatic or blood vas-

cular spread e.g. lymphangitis lymphadenitis and chills. The entire wound is usually involved and diffuse redness and edema of the subcutaneous tissue are observed. Pus is slow to form.

**Diagnosis**—The clinical picture will be highly suggestive. Smear of the wound exudate will show the characteristic organisms as diplococci or short chains. Blood culture may be positive very early in the course of the infection.

**Treatment**—*Surgical*—Treatment in advance of pus formation should be limited to the removal of any sutures which may have been placed in the wound. After abscess formation occurs in the wound or regional lymph nodes drainage should be instituted. Exudate which forms in pleural or joint cavities should be removed by aspiration.

**Chemotherapy**—*Sulfanilamide* should be given as follows: Initial dose 6 gm. followed by 1 gm. every four hours day and night until the infection is under control as evidenced by subsidence of fever and local signs. Thereafter 1 gm. should be given every six hours for about a week. Open wounds infected with hemolytic streptococci should be dusted daily with sulfanilamide powder.

**Immunotherapy**—If the patient develops a scarlatiniform rash he should receive scarlet fever antitoxin. Otherwise serum is of no value.

**Staphylococcal Infections**—*Source*—Although staphylococci are widely distributed on the skin and in the respiratory passages many of them are nonpathogenic. Contamination with some staphylococci should be expected in every wound.

**Clinical Course**—There are two varieties of staphylococcal infection: one the highly invasive variety resembles hemolytic streptococcal infection in signs and clinical course and the other a localized type of infection limited perhaps to a stitch hole or to a portion of a wound resemble a localized furuncle. In some cases there will occur both a localized carbuncular type of lesion surrounded by an area of cellulitis and a diffuse invasive infection of the blood stream. The development of blood stream invasion is frequently associated with thrombophlebitis of a vein draining the primary focus of infection. The



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4. Sulfanilamide may be introduced for prophylactic purpose into the peritoneal or pleural cavity intrajoint or applied to the brain without interfering with wound healing. However the local concentration will only remain in the effective range for about forty-eight hours. Hence it is important to supplement local treatment by oral administration.

### TREATMENT OF SPECIFIC TYPES OF WOUND INFECTIONS

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formation of multiple metastatic foci in lungs kidneys and bone is to be expected after bacteremia but many of the foci will resolve without formation of pus if the patient recovers.

**Diagnosis**—In the case of the localized variety the clinical signs will be suggestive of the type of infection. Otherwise the exact diagnosis can be made only by culture of the organisms from the infected wound or from the blood stream.

**TREATMENT**—*Surgical*—The involved portion of the wound should be opened widely and localized abscesses should be drained as soon as the diagnosis of wound suppuration can be made. The surgeon should postpone particularly the surgical drainage of abscesses of the face making use of hot wet dressings to favor resolution. In those cases in which extensive necrosis occurs as in carbuncles complete excision of the lesion may be desirable.

*Chemotherapy*—*Sulfathiazole* should be given to every patient with a staphylococcal infection which gives evidence of invading either the local tissues or the blood stream. An initial dose of 6 gm. should be followed by 1.5 gm. every four hours until the temperature has been normal for forty-eight hours. Thereafter the dose may be reduced to 1 gm. every four hours but in the case of disseminated infections should be continued at this level for ten to fifteen days or longer. Recurrence of infection is likely if the drug is stopped too soon. If facilities for determination of the concentration of sulfathiazole in the blood are available and the infection is serious an effort should be made to keep the blood level above 10 mg. per 100 cc. until the infection is under control in solutions of sodium sulfathiazole intravenously if necessary. In those cases in which large doses are given it is important for the patient to maintain a urine output of over 1200 cc. daily. The physician should watch for oliguria and other evidences of toxicity.

*Open wounds* infected with staphylococci should be treated by applying a thin layer of powdered sulfathiazole locally using about 1 gm. for each 10 square inches of surface. Moist saline dressings should be used on top of the sulfathiazole and

the entire dressing may be changed as seems indicated in the individual case

**Gas Gangrene**—Gas gangrene comprises a group of infections due to *Clostridium welchii*, *Clostridium oedematiens*, *Vibrio septique* and still other anaerobic bacteria

**Source**—The excreta of animals and man and soil or clothing which have been contaminated by such excreta are the principal sources of the anaerobic bacilli which cause gas gangrene. While many wounds contain organisms of this group the incidence of actual gas gangrene is limited almost entirely to wounds which contain devitalized muscle tissue. The infection after it starts is principally one of muscle bundles. The presence in a wound of pathogenic staphylococci or hemolytic streptococci mixed with anaerobes probably favors the subsequent development of gas gangrene.

**Clinical Course**—The first sign of the development of gas gangrene in a wound is likely to be the feeling of pain in a hitherto painless wound followed by an abrupt rise in pulse and temperature. The wound shows redness, edema and severe tenderness and a frothy exudate may appear. Palpation or auscultation may reveal crepitation. An x-ray examination showing gas in the muscle bundles will aid in the diagnosis provided the other signs of the infection are present. The infection spreads rapidly unless prompt treatment is instituted and early death from overwhelming toxemia is not uncommon.

**Diagnosis**—The diagnosis is made on the basis of the clinical signs described above together with the finding of characteristic rods on smear and anaerobic culture. It is advisable whenever possible to determine by guinea pig inoculation the pathogenicity of anaerobes found in wounds which fail to show characteristic signs of infection because many wounds which have been contaminated by feces will show *Clostridium welchii* even though clinical gas gangrene does not develop.

**TREATMENT**—**Surgical**—Surgical treatment should aim at the opening up of all planes along which the infection has traveled and the excision of all infected muscle. Amputation need

formation of multiple metastatic foci in lungs kidneys and bone is to be expected after bacteriemia but many of these foci will resolve without formation of pus if the patient recovers.

**Diagnosis**—In the case of the localized variety the clinical signs will be suggestive of the type of infection. Otherwise the exact diagnosis can be made only by culture of the organisms from the infected wound or from the blood stream.

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resort may be made to chemical debridement with *Carrel Dakin technic*. This is best employed in the classical manner which requires the careful placing of small perforated rubber tubes throughout the wound and the semicontinuous irrigation through them of freshly prepared solution of hypochlorite. The surrounding skin should be protected with vaseline gauze and the wound itself covered with a bulky dressing through which pass the rubber tubes.

**Burns**—It is not uncommon for infection of the raw surfaces of burns to develop either with or without the use of protective eschars. The hemolytic streptococcus is a frequent offender in infections of this sort. It has been reported that the topical application of *powdered sulfanilamide* or *sulfathiazole* in these cases will bring about a rapid subsidence in the signs of acute infection and a disappearance of the organisms from the wound. The sulfonamide is applied with a salt shaker or insufflator in the amount of 1 gm. for each 10 square inches of surface. A protective dressing of gauze moistened with saline and covered with vaseline gauze to prevent drying may then be used. This dressing should be changed once daily.

Such wounds may be covered with small deep (pinch) grafts as soon as the signs of infection have subsided and the cultures have become negative for hemolytic streptococcus. The sulfanilamide saline dressings are applied directly to the grafts. If another type of graft is called for a somewhat longer period of delay will be necessary in order to avoid the possibility of recurrent infection.

be done only if necessary in order to remove all of the involved tissue

*Chemotherapy*—Sulfathiazole should be given according to the same dose schedule outlined previously for staphylococcal infections

*Local Treatment with Zinc Peroxide*—The best material for local treatment after excision of the involved muscle is *zinc peroxide Medicinal Grade*. It is suspended in water to form a creamy emulsion and is then used to flood the entire wound. A gauze or cotton packing soaked in zinc peroxide cream is then carefully applied to all portions of the wound. The entire dressing should be sealed in with some material which is completely impervious to water such as vaseline gauze in order to prevent drying of the zinc peroxide. The dressing should be changed every day or two, the wound being thoroughly irrigated with saline at each time.

*Serum Therapy*—Every patient suffering from gas gangrene should receive an initial dose of about four therapeutic doses of polyvalent antitoxin intravenously diluted in saline followed by one or two therapeutic doses every eight hours according to the severity and course of the infection. Each therapeutic dose contains 10,000 units of *Clostridium welchii* antitoxin and variable amounts of antitoxin of the other members of the group.

*Miscellaneous Infections—Mixed Infections in Mouth and Jaw Wounds*—Wounds of the mouth and jaws are likely to become infected with anaerobic streptococci mixed with other anaerobic bacteria which normally inhabit the mouth. In the prevention and treatment of these infections the best agent available at this time for local use is *zinc peroxide Medicinal Grade*. It may be used as a mouth wash or as a dressing. (For detail of its use see the section on treatment of gas gangrene.)

*Necrotic Sloughing Wounds*—A wound which contains a large amount of necrotic slough will tend to be quite resistant to sulfonamide or zinc peroxide therapy. When surgical removal of the large masses of infected slough is impractical

# IMPROVISED DRESSINGS AND EQUIPMENT TRANSPORTATION OF THE INJURED

CARLTON L. ANDRUS M.D. F.A.C.S.

C O M C U S ES N Y B MED CIV  
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## IMPROVISED DRESSINGS AXIOMATIC CONSIDERATIONS

It may be well to set forth at the beginning certain axiomatic considerations which are related to the application and use of improvised dressings

1 All body wounds presenting a solution of the continuity of the body tissues in which the skin is involved require dressings

2 A wound dressing includes everything that is used to cover or dress the wound. It usually consists of a gauze pad or compress applied directly to the wound and held in place by a bandage

3 Dressings may be applied to wounds as a means of controlling hemorrhage and are used to exclude infection as well as to protect the wound from further injury

4 The pad or compress of a dressing must be sterile

5 Especially prepared sterile dressings or compresses are superior to improvised dressings

6 Improvised dressings are used only when surgically sterile dressings are not available. This implies that improvised dressings are for use in emergency situations

The following considerations must be kept in mind when one is called upon to improvise a dressing in the first aid emergency treatment of any wound

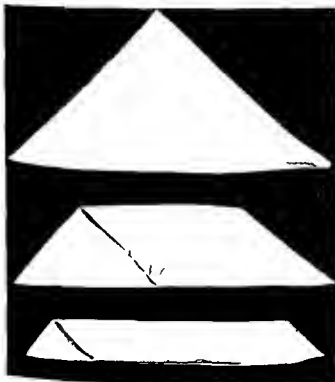
The purpose of this assertion is to indicate that the purpose of these first aid dressings is to be tried. The first aid dressing is to be tried.





quickly improvised from any kind of cloth such as an old sheet shirt neckerchief or tea towel. If the material at hand is not large enough to make the bandage full size it can nevertheless be used by tying available strips of cloth to the ends in order to increase its size.

The triangular bandage is made with a piece of cloth 36 to 40 inches square the larger size being preferable for adults.



F 374—Folded triangular

The square of cloth is then folded diagonally to make one bandage or may be cut diagonally to make two bandages.

The uses and methods of applying the triangular bandage are described in the Handbook of the Hospital Corps United States Navy 1939 as follows:

The long side of the triangle is called the *base* the point

## TYPES OF DRESSINGS AND THEIR IMPROVISATION

**Pad or Compress** — A pad or compress should be provided. Freshly laundered handkerchiefs, napkins, pillow slips, towels, or similar articles or materials may be used. The cloth should be carefully unfolded and only that part of it that has not been touched by the hands or any other object should be placed in direct contact with the wound. If such materials as those mentioned are not at hand, take the cleanest cloth available and render it *sterile* by scorching it with a hot iron on top of the stove, in the oven over a gas flame or open fire, by candle flame, matches or other means. When this is being done a certain amount of carbon may collect on the cloth but it will be sterile and not sufficient in amount to harm the wound when the compress is applied.

If means are at hand to heat water and time will permit, take the most suitable piece of cloth, preferably cotton, that is available, fold it into a pad of proper size to cover the wound and boil for from ten to fifteen minutes. Then wring out as much water as possible, unfold to expose an untouched surface and apply directly to the wound.

To apply the dressing, any one of four types of bandage, namely the *roller*, *triangular*, *four tailed* or *T bandage*, may be used. Each type of bandage can be supplied readily by improvisation and the choice as to which one shall be employed will be determined by the material available, the size and location of the wound.

**Roller Bandage** — When a roller bandage is required, as the case in wounds of the extremities, it can easily be made by tearing any piece of cloth or garment of clothing that is available, such as sheet, handkerchief or shirt, into strips of the desired width. A necktie or cloth belt may serve as is in certain instances. When the strips of bandage material at hand are not of the desired length, two or more pieces can be tied together by means of the square or reef knot.

**Triangular Bandage** — The triangular bandage is of great value because of its adaptability to wounds that involve almost any part of the body and because it can be readily and

elbow. Drop one end of the triangle over the shoulder on the uninjured side and let the bandage hang down over the chest with the base toward the hand and the apex toward the elbow. Slip the bandage between the body and the arm, carry the



Fig. 375—Front and back views of head bandage.

lower end up over the shoulder on the injured side and tie the two ends to either at either side of the neck using a square knot. Draw the apex of the bandage toward the elbow until it is snug. Bring it around the elbow to the front and after folding it back a little fasten it to the front of the bandage with a

opposite the base is called the *apex* and the points at each end of the base are called the *ends* or *extremities*. The *c* bandages may be used either as a triangle or as a cravat the latter being made from the triangle by bringing the apex to the base and folding it upon itself a sufficient number of times to obtain the width desired (Fig. 374).

The names of these bandages indicate the part of the body to which the base is applied, the location of the apex, and the shape. For example, in the *fronto occipital triangle* the base of a triangular bandage is applied to the forehead and the apex is carried to the occiput, and in the *merito et tico occipital cravat* the middle of the base is placed under the chin and the end carried over the vertex of the skull to the occiput. A few of the more commonly used triangular bandages will now be described.

*Fronto Occipital Triangle*—Place the middle of the base of the triangle on the forehead so that the edge is just above the eyebrows and bring the apex backward over the head allowing it to drop over the occiput. Bring the ends of the triangle around to the back of the head above the ears, cross them over the apex at the occiput, and carry them around to the forehead and there tie them in a square knot. Finally, turn up the apex toward the top of the head and pin with a safety pin, or turn up the apex and tuck it in behind the crossed part of the bandage. Use: To retain dressings on the forehead or scalp (Fig. 375).

*Triangle of Chest Back*—Drop the apex of the triangle over the shoulder on the injured side and bring the bandage down over the chest (or back) to the level desired and so that the middle of the base is directly below the shoulder. Carry the end around the body and tie in a square knot on the back. Finally bring the apex down on the back (or chest) and tie it in a square knot to one of the ends. Uses: To retain dressings on burns or wound of the chest or back (Fig. 376).

*Brachio cervical Triangle or Arm Sling*—The arm to be put in the sling should first be bent at the elbow so that the little finger is about a hand's breadth above the level of the

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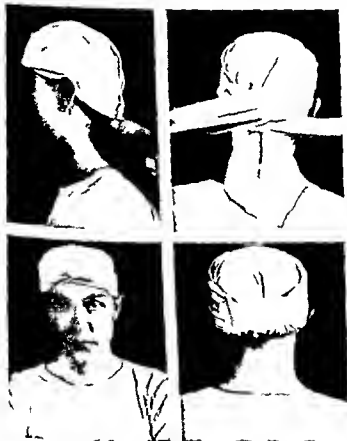


Fig. 375.—First position of triangular bandage

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**Triangle to Chest or Back** —Drop the apex of the triangle over the shoulder on the injured side and bring the bandage down over the chest (or back) to the level desired and so that the middle of the base is directly below the shoulder. Carry the end around the body and tie in a square knot on the back. Finally bring the apex down on the back (or chest) and tie it in a square knot to one of the ends. *Use* —To retain dressings on burns or wounds of the chest or back (Fig. 376)

**Back cervical Triangle or First Skin** —The arm to be put in the sling should first be bent at the elbow so that the little finger is about a hand's breadth above the level of the

apex around the ends of the fingers and over the dorsum of the hand to the wrist or forearm fold each half of the part at



Fig 3 — B h l l g l m h g h g l d p e be  
t ee m d b d

the sides of the hand back toward the opposite side of the wrist cross the end around the wrist and tie in a square knot



safety pin. The lower end of the bandage may be passed between the arm and the body and under instead of over the injured shoulder before tying to the other end. The end of the



F 36—Triangle of Hand

fingers should extend slightly beyond the base of the triangle (F 377)

*Triangle of Hand*—Place the middle of the base of the triangle well up on the palmar surface of the wrist; carry the

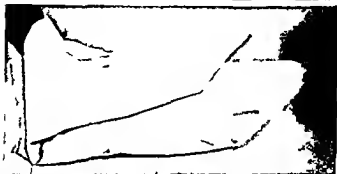
*Triangle of Foot*—Place the middle of the base of the triangle on the ankle well above the heel carry the apex around the ends of the toes and over the dorsum of the foot to the ankle fold each half of the part at the sides of the foot back



FIG 379—T g l f f t

toward the opposite side of the ankle cross the ends around the ankle and tie in a square knot Uses To retain dressings of considerable size on the foot (FIG 379)

*Gluteo femoral Triangle*—To apply this bandage requires



F 378-T gl f h d

U es To retain dress nos f considerable size on the hand  
(F) 378)

as a temporary dressing to secure fixation of the parts in fracture or dislocation of the jaw (Fig 381)

*Bis axillary Cravat*—After making a triangle into a cravat of the proper width place the middle of the cravat in the axilla carry the ends upward to the top of the shoulder crossing them there and continuing across the back and chest respectively to the opposite axilla where they are tied in a square knot Uses To retain dressings in the axilla or on the shoulder (Fig 382)



Fig 381—Mittelpunkt

*Cravat of Head or Ear*—After making a triangle into a cravat of the proper width place the middle of the cravat over the point desired carry the end to the opposite side of the head cross them and bring them back to the starting point and tie with a square knot Use To apply pressure to control serious hemorrhage from wound (Fig 383)

The triangular bandage has many other uses in addition to those mentioned Its application in other type of dressing to provide traction in fractures of the extremities to hold in

two bandages one a triangle the other a cravat First fasten the cravat around the waist Place the base of the triangle in the gluteo femoral fold and carry the ends around the thigh to the front where they are tied with a square knot The apex is then carried upward and passed under the cravat around the



Fig. 350—Gluteo femoral triangle

waist turned down and fastened to the triangle with a safety pin Uses To retain dressing on the buttock or hip (Fig. 350)

*Mentoretrooccipital Cravat*—After making a triangle into a cravat of the proper width place the middle of the cravat under the chin carry the end upward in front of each ear to the vertex of the skull crossing them there and continuing downward to the occiput where they are tied in a square knot Uses To retain dressings on the chin cheeks and scalp and

dress in place. This bandage is particularly useful in dressing wounds of the *chin, lower jaw* and *nose*.

A similar or many tailed bandage made by splitting the ends of the cloth into several strips equal in number on each side is especially well adapted for dressing wounds of the *abdomen*. For this purpose the body of the bandage should be placed centrally across the midlumbar portion of the back. The tails of the bandage are brought forward over the abdomen and



Fig. 383—C t f h d

are tied to secure the wound compress in place. If alternate rather than opposite tail of the bandage are tied together the dressing will conform more closely to the contour of the abdomen and will remain in place much better.

**T Bandage**—The T bandage can be improvised from any available strips of cloth. It consists of a horizontal bandage to which is attached about its middle a vertical bandage of approximately one half the length of the horizontal one. The horizontal portion is employed to secure the bandage to the body while the vertical portion is used to secure the dressing compress in place.

provided splints and to serve as a sling to support the arm are described and illustrated in the First Aid Text Book of the American Red Cross the Soldiers Handbook United States Army and the Handbook of the Hospital Corps United States Navy

**Four tailed and Many tailed Bandages** —The four tailed bandage derives its name from its appearance and is readily



F 352—B Illustration

improvised from any strip of cloth which is approximately 3 feet long and 2 to 8 inches wide its dimensions depending upon the size of the wound and the purpose for which it is intended To make it the strip of cloth is split lengthwise to within a few inches of the center thus providing a bandage with a body and four tails The body of the bandage is placed over the pad or compress used in dressing the wound and the tails are carried around the related part of the body and tied to secure the

dressing in place. This bandage is particularly useful in dressing wounds of the *chin lower jaw and nose*.

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Fig 383—C t f h d

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This bandage is especially useful in dressing wounds of the *perineum* and about the *anal opening*. When used for this purpose the horizontal portion is placed around the abdomen above the iliac crests in such a manner that the vertical portion rests on the midline of the back. The vertical portion is brought forward between the thighs and then upward to be secured to the anterior horizontal portion of the bandage. By longitudinally splitting the free end of the vertical portion of the bandage through about half its length two strips are made which can be carried upward on either side of the external genitalia before being secured to the horizontal portion of the bandage.

### IMPROVISED EQUIPMENT

It is recognized that especially designed equipment of proved efficiency is superior to that which is improvised. Improved equipment is used primarily to meet emergency situations and should as nearly as possible fulfill the requirements of standard equipment. The scope of equipment improvisation is limited only by the ingenuity of those called on to utilize whatever material are at hand to meet the need of a given situation. For the purposes of this paper it is felt that the discussion of improvised equipment should be limited to those devices that may be employed in the management of wounds and injuries.

**Tourniquet**—In the control of hemorrhage from wounds of the extremities the necessity may arise to apply an improvised tourniquet around the forearm, a hand breadth below the axilla or around the thigh about the same distance below the groin. The *Spiral Handlass* may be used. It consists of a flat band of any cloth at least 1 inch wide, a piece of rope or wire is not suitable. The triangular bandage folded to form a cravat is ideal for the purpose but a belt, towel, handkerchief or other similar article can be used. The tourniquet is applied preferably with a pad placed directly over the brachial or femoral artery but can be used merely as a constricting band without the pad. In either case if the article used as a bandage is long enough it should be wrapped around the limb

twice and the ends tied in a half knot. Place a short stick, bayonet or similar object on the half knot and tie a square knot over that. Twist the stick rapidly to tighten the tourniquet until the pressure on the artery stops the flow of blood. Do not tighten more than is necessary to control bleeding. When the tourniquet has been adjusted hold the stick in position by means of the ends of the bandage already applied or by means of another bandage looped around the end of the stick and secured to the injured limb.

The tourniquet is a useful item of equipment but it can also be dangerous. It should not be left in place for more than fifteen to twenty minutes without loosening, because of the danger that necrosis of the distal part may result if the blood supply is insufficient. Do not tighten the tourniquet again unless bleeding persists.

**Splints and Traction**—All fractures or suspected fractures of the extremities require the application of splints either with or without traction. These should be improvised to suit the needs as determined by the location and type of fracture.

**FIXED TRACTION**—Improvised fixed traction splints may be made from boards about 4 inches wide and  $\frac{1}{2}$  inch thick with  $\frac{1}{2}$  notches cut in the end.

**Fractures of Lower Extremity**—For fractures of the leg the board should be long enough to reach from about 12 inches above the hip to about 12 inches beyond the foot. The method of application is as follows:

1. Apply manual traction on the foot.
2. Apply traction hitch to foot by placing center of a triangular bandage cravat under center of foot like a stirrup. Cross the two ends over the instep, pass both ends back and around behind the foot, crossing above the heel and then pass them both forward, slipping them under the first stirrup loop. Maintain traction.

Slip a second cravat under leg until center of bandage is in crotch. Tie end above hips in square knot forming loose loop into which the notch at the proximal end of splint can be placed. Again tie end of cravat around splint to hold loop in place.

This bandage is especially useful in dressing wound of the *perineum* and about the *anal opening*. When used for this purpose the horizontal portion is placed around the abdomen above the iliac crests in such a manner that the vertical portion rests on the midline of the back. The vertical portion is brought forward between the thighs and then upward to be secured to the anterior horizontal portion of the bandage. By longitudinally splitting the free end of the vertical portion of the bandage through about half its length two strips are made which can be carried upward on either side of the external genitalia before being secured to the horizontal portion of the bandage.

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blankets newspapers boards bayonets rifles and similar semi rigid or rigid articles may be used Their uses and methods of application are described in texts on first aid

### TRANSPORTATION OF THE INJURED

The subject of transportation of the injured is exceedingly broad in scope and it will not be possible in this paper to discuss in detail the various means of transportation that may be employed to meet the requirements of widely diversified situations

Transportation of the injured may involve on the one hand the removal of a single individual from the scene of an automobile accident that takes place around the corner from a hospital or it may on the other hand involve the removal of large number of persons from the battlefield to distant hospitals

There are problems in the transportation of patients under conditions obtaining in civilian life problems in the transportation of casualties occurring when the Army is in action and problems in the transportation of the injured in a naval engagement

The transportation of these injured may involve travel by land water or air and each will require considerations and facilities peculiar to the situation at hand

Phases of the subject of transportation of the wounded that may stimulate interest in the pertinent studies articles and reports which are available in the literature are the following technique of the hand carry of the injured use of stretchers both regular and improvised and of civilian and military ambulances and other means of transport for the injured in the field various methods of shore to ship evacuation during expeditionary operations use of hospital trains hospital and ambulance ships as well as ambulance and utility planes

It may be observed that such factors as the place conditions under which the injury was received the distance from the scene of injury to the logical destination of the patient the conditions to be encountered during transportation and the number of persons to be carried all enter into the problems of transportation

4 Tie traction bandage or pieces of small rope to the end of the ankle hitch and pull them downward into the notch at the distal end of the board splint and then upward to take out all slack. Next pass the end in opposite directions around the splint and tie firmly with a square knot.

5 Insert a strong short stick between the traction bandages distal to the foot and twist until the desired traction is obtained.

6 Place any available padding material between leg and splint to relieve pressure points.

7 Apply a sufficient number of wide bandages or cravats around leg and splint from hip to ankle to immobilize the extremity.

8 The heel of the injured leg should not be allowed to rest on the ground. To make sure that it does not, the lower end of the splint should be supported from below or held up by a rope loop from above.

*Fractures of Upper Extremity*—Fractures of the upper extremity can be handled in a similar way by applying traction to the hand. This is done by rolling a small stick about 4 inches long into the center of a triangular bandage. The rolled up stick is placed in the palm of the hand with fingers and thumb closed around it to form a fist. A second cravat bandage is wrapped around the hand and wrist to maintain the hand in the first position. The end of the bandage rolled around the stick protrudes beyond the thumb and little finger. They are used as traction bands. They are passed through the notch at the distal end of the arm splint and secured. Traction can be obtained either by direct pull or by twisting stick as is done with the leg splint. Use no more traction than is necessary.

**OTHER METHODS OF IMMOBILIZATION**—It is the opinion of leading fracture specialists in the United States that fixed traction is the ideal first aid or emergency treatment of fractures. Cases may arise, however, in which the inability to obtain the necessary material or older methods of attempted immobilization must be employed and splints applied without traction. For this purpose such improved splints as pillows folded

# INTRAVENOUS FLUID THERAPY IN SHOCK

NORMAN E. FREEMAN M.D. F.A.C.S.

M. J. MED. AL. RESER. C. U. S. ES. A. Y. M. ER. S.  
COM. TITLE. S. OC. N. VAL. R. SEA. C. U. IL. A. ISTA. PRO.  
SO. OF. RE. CH. S. ERY. H. SON. D. AR. S. TE. SCHOOL.  
Med. U. N. I. V. E. R. S. I. T. Y. O. F. S. Y. L. I. A.

SHOCK is the clinical condition characterized by progressive loss of circulating blood volume resulting from increased capillary permeability. Failure of the peripheral circulation naturally follows the discrepancy between the size of the vascular bed and the volume of intravascular fluid. This peripheral circulatory failure leads to capillary stasis, tissue anoxia and further increase in capillary permeability. Replacement of the intravascular fluid in order to re-establish an adequate peripheral circulation becomes therefore the most important feature of the prevention and treatment of shock.

The volume of fluid contained within the blood vessels is only about one half of that present in the tissue spaces of the body as a whole and only one fifth as great as that contained within the cells of the body. It is of vital importance however to maintain constant the volume of fluid within the blood vessels since the function of all the cells of the body is dependent upon an adequate circulation of blood. Under normal conditions the intravascular fluids are kept constant according to Starling's original concept through a balance between the hydrostatic pressure forcing fluid out of the capillaries and the colloid osmotic pressure of the plasma proteins drawing fluid into the blood vessels. Examples of this balance are seen when the plasma volume is measured by the dye method during the intravenous injection of a crystalloid (5 per cent glucose solu-

F. th. H. so. D. p. tm. t. f. S. p. l. R. & h. S. h. l. l. Med.  
l. rs. t. f. P. l. Ph. l. d. l. ph.

In the foregoing paragraphs reference has been made to the broader aspects of the subject. However certain fundamental considerations that are related to the initial removal of patients from the scene of injury must be dealt with. These considerations include the determination of the nature and extent of the injury, the adequacy of dressings and splints in immobilizing the injured parts, the general condition of the patient, the need for care in handling the patient, protection and comfort of the patient, his covering, and the means of combating shock together with reasonable assurance that the patient will arrive at his destination without further injury.

Patients who have sustained *fractures* particularly those cases in which bones of the *neck* or *back* are involved require special care and handling while being transported in order to be comfortable and insofar as possible free from danger of further injury. If standard equipment is at hand or material are available for improvisation fractures of the extremities should be immobilized with traction before the patient is transported from the scene of injury. A patient who has a fractured neck should be transported lying on his back while the patient with a fractured back should be transported lying on his abdomen. In cases in which both neck and back are fractured the patient should be transported as if only the neck were broken. If help is available one person should be detailed to watch the patient's head while the patient is being moved.

The best method of transporting patients from the scene of injury are by ambulance stretcher, Army litter or Navy Stokes stretcher. These however are not always available and even if they are they cannot always be used because the access to or exit from the scene of injury will not permit. The detail of hand carry, the various methods of improvising stretchers and detailed descriptions of many different types of especially designed stretchers will be found in texts on first aid in service handbooks and in the literature on the subject.

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 Chief Surgeon General's School  
 Staff Lieutenant Colonel  
 Medical University of Pennsylvania

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From the Department of Surgical Research School of Medicine  
 University of Pennsylvania Philadelphia



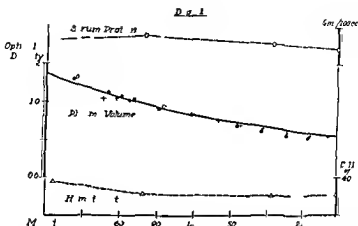


Fig 384—C f d o p p e f d y T 18 4 f m t h b l o o d t r e m  
 D g 1 g h t 25 k g T t y m g f d y j e c t d i l y t a r  
 t m t h k p t S m p l c e t t d  
 h m a t t l f p m t g t e p d b t m f h r t  
 l t h t h f l l g f u e s d u n t r e p e s e t p t l d n s t y f s e r u m  
 h m l t d a c m p t c e r a t b e c a u s e t m m t (R  
 p e d t h h t y f A m J P h y l)

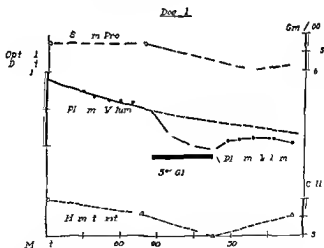


Fig 385—E f f t i n t i n j e c t f 500 f 5 p e t g l s e  
 p l m l m s e m p t c e d h m D g 1 2  
 k g (R p r i n t e d t h g h r t s y f A m J P h y l)

tion) or a hypertonic colloid (four times concentrated serum). Figure 384 represents the normal disappearance curve of the dye from the circulation. During the intravenous administration of 500 cc of a 5 per cent solution of glucose as shown in Fig 385 the concentration of the dye decreased with a fall in the serum protein concentration and a drop in the hematocrit. However almost two fifths of the injected fluid had left the blood stream by the time that the injection was finished since

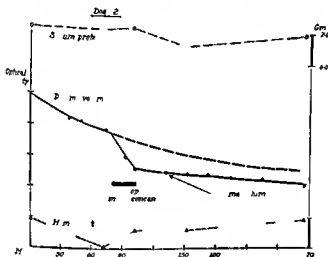


Fig 385—Effect of intravenous administration of 500 cc of a 5 per cent solution of glucose on the disappearance of the dye from the circulation. (Am J Phys 1)

the increase in plasma volume was but 330 cc. In the succeeding hour another two fifths of the injected fluid containing the crystalloid glucose had left the circulation. In comparison Fig 386 shows the sustained decrease in dye concentration observed when a solution of colloid 40 cc of four times concentrated lyophilized serum was injected. The increase in plasma volume 143 cc was approximately equivalent to four times the quantity of fluid injected. Since the concentration of serum protein was essentially unchanged the injected protein

must have been diluted by fluid drawn into the blood stream from the tissue spaces

#### NATURE OF FLUID LOSS ITS REPLACEMENT

Replacement of intravascular fluid must take into consideration the nature of the fluid lost. The character of fluid lost will be considered under four categories—water, electrolyte, plasma and blood.

**Loss of Water**—The normal individual who is not exposed to excessive heat loses approximately 1500 cc. daily through vaporization from the lungs and skin. This amount is increased by fever. The loss is in the form of water, except under conditions of excessive sweating, and should be replaced by giving water without added salts. If it cannot be replaced by the taking of food and fluids by mouth, it should be replaced by giving 5 per cent glucose solution intravenously. In the presence of normal kidney function, 800 to 1000 cc. of urine are sufficient to excrete the waste material. The kidney displays a remarkable ability to retain salt if needed, so that the amount of fluid lost through urine needs to be replaced simply by water. Dehydration is frequently advanced when the patient is first observed. Under such circumstance, sufficient fluid should be given to make up for the amount lost previously. The studies of Coller and Maddock have shown that clinical signs of dehydration are generally present when the patient has lost approximately 6 per cent of his body weight. Replacement of this loss should be considered in an estimation of the total quantity which the patient requires.

**Loss of Water Plus Electrolytes**—Dehydration is frequently produced by the loss of fluid from the gastrointestinal tract. Since all the secretions of the gastrointestinal tract are approximately isotonic with blood serum (Peters), replacement of the fluids lost through vomiting or drainage, volume for volume, by physiological saline or by Ringer's solution is indicated. In order to care for the depletion of salts from which patients are suffering due to the loss of electrolytes prior to observation, Coller and Maddock have developed a clinical rule

which states that for each 100 milligrams that the plasma chloride level needs to be raised to reach the normal (560 milligrams per cent) the patient should be given 0.5 gram of sodium chloride per kilogram of body weight.

Although the secretions of the gastro intestinal tract are approximately isotonic with blood serum the proportion of ions varies in the different regions. Loss of acid gastric contents may lead to serious alkalosis. Drainage of secretions from the upper intestinal tract in which large quantities of sodium ions are lost may lead to acidosis. The kidney however if it is supplied with an adequate quantity of sodium chloride and water and if it is capable of normal function is able to regulate excretion of the different ions in order to preserve the proper balance.

**Loss of Plasma.**—By far the most serious loss as far as the production of shock is concerned is occasioned by the loss of fluid with protein. This loss is encountered in severe burns, crushing injuries of the extremities, intestinal distention and any condition associated with injury to the capillaries causing an increase in their permeability. Chemical analysis of the fluid lost from the blood stream into the tissue spaces after burns and after mild trauma to an extremity has shown that the fluid which accumulates or escapes from the region of injury has essentially the same composition as blood plasma. Analysis has not been made of fluid escaping from the capillaries due to a general increase in their permeability such as occurs after prolonged low blood pressure from uncomplicated hemorrhage but the fact that hemoconcentration occurs indicates that fluid plus protein is probably lost from the circulation. Replacement of the fluid lost from the blood stream under these circumstances must be made by the administration of fluid containing protein.

At the present time the administration of plasma or serum either in the liquid form or redissolved from that dried in the frozen state appear to offer the best solution to the problem presented by patients who have lost appreciable quantities of fluid containing protein. The importance of having available a plasma bank can hardly be overemphasized. Cross matching

is not necessary if the plasma from a number of donors is pooled

*Calculation of Plasma Requirements*—The quantity of plasma needed to replace that lost from the blood stream can be roughly calculated from the concentration of the formed elements in case there has not been simultaneous loss of red blood cells. Methods have been suggested by Black, Elkinton, Wolf, and Lee, and Harkins<sup>1</sup> for calculating the amount of plasma required in the treatment of severe burns. Each of these methods assumes that red blood cells have not been lost. The simplest formula is that given by Harkins<sup>4</sup> and is as follows: For every point the hematocrit is above the normal of 45 give 100 cc. of plasma. For children the amount of plasma is calculated proportionately according to body weight with the average adult weight set at 70 kg. If the plasma protein level is below normal this method gives too low a value. In such a case an additional 25 per cent of the calculated amount of plasma should be added for every gram the protein level is below 6 gm. per cent.

In case that it is possible to measure only the hemoglobin concentration the formula of Black may be used:

$x = \text{amount of plasma to be given in cc. per liter}$

$$x = \left(5 - \frac{500}{\text{Hb}}\right) 1000 \quad \text{here Hb is the hemoglobin observed after the burn}$$

*Loss of Blood*—The loss of oxygen-carrying red blood cells from hemorrhage either through external bleeding or through loss of blood into traumatized tissues is not of as great significance in the production of shock as is the loss of blood volume. An effective circulation can be maintained with but 20 per cent of the normal oxygen-carrying capacity of the blood. The volume of the circulating blood is far more important since its reduction by as little as 35 per cent may lead to shock.

In the treatment of hemorrhage *transfusion* of blood is indicated though many investigators have found that the administration of serum and plasma both normal and concen-

trated have been as effective as that of blood. Magladery, Solandt and Best have emphasized the fact that the volume of red blood cell restored to the animal is more important than their oxygen-carrying capacity.

Adequate replacement of blood lost is a difficult matter to judge. Since equal amounts of all the elements of the blood are lost in hemorrhage replacement cannot be guided by observed alterations in the proportion of the different components. The administration of blood plasma or serum must be determined by the clinical condition of the subject and the circulatory response to treatment. Criteria of shock are needed to guide intravenous therapy.

#### CRITERIA OF SHOCK

**Blood Pressure**—Blood pressure is not in itself a reliable criterion of shock since through vasoconstriction the pressure in the larger arteries is frequently maintained in spite of a lowered blood volume and reduced cardiac output. Johnson and Blalock have shown that the cardiac output declines well before the blood pressure as shock comes on. A reduced blood pressure in the presence of other signs of shock is of great significance but a normal blood pressure does not necessarily signify that the circulation is adequate.

**Pulse Rate**—The pulse rate is not entirely reliable as a criterion in the primary or neurogenic type of shock; the pulse is usually slow. Again it may be slow even in the presence of severe intraperitoneal hemorrhage (Phemister).

**Hemoconcentration**—Hemoconcentration has been suggested as a diagnostic sign of shock and as a means of differentiating this condition from hemorrhage (Moon<sup>2</sup>). Although the primary response to hemorrhage is dilution of the blood when shock is produced even by uncomplicated hemorrhage concentration of the blood is observed (Blalock, Freeman and associates). In recent investigations on the circulation in shock produced by trauma to the extremities of dogs under ether anesthesia<sup>3</sup> it was found that concentration of the red blood cell was not significantly increased if there was a considerable loss

is not necessary if the plasma from a number of donors is pooled

**Calculation of Plasma Requirements**—The quantity of plasma needed to replace that lost from the blood stream can be roughly calculated from the concentration of the formed elements in case there has not been simultaneous loss of red blood cells. Methods have been suggested by Black, Elkinton, Wolff and Lee, and Harkins for calculating the amount of plasma required in the treatment of severe burns. Each of the methods assumes that red blood cells have not been lost. The simplest formula is that given by Harkins<sup>1</sup> and is as follows: For every point the hematocrit is above the normal of 45 give 100 cc of plasma. For children the amount of plasma is calculated proportionately according to body weight with the average adult weight set at 70 kg. If the plasma protein level is below normal this method gives too low a value. In such a case an additional 25 per cent of the calculated amount of plasma should be added for every gram the protein level is below 6 gm per cent.

In case that it is possible to measure only the hemoglobin concentration the formula of Black may be used:

$x = \text{amount of plasma to be given in cubic centimeters}$

$$x = \left(5 - \frac{500}{\text{Hb}}\right) 1000 \quad \text{where Hb is the hemoglobin observed for the burn}$$

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of binding the traumatized extremities is illustrated in Fig 387 It follows then that hemoconcentration is not a reliable criterion of shock in which there is an element of hemorrhage

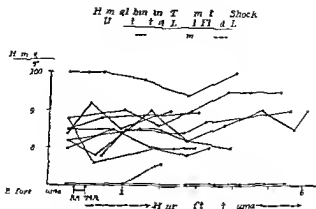
**Reduced Circulation**—A reduction in circulation is probably the most reliable criterion of shock as the investigations of Erlanger Gesell and Gas er disclosed at the close of the last war Studies in clinical cases of surgical shock have confirmed these observations The time relationship between diminished peripheral blood flow reduced blood pressure and hemoconcentration in a series of experiments on traumatic shock<sup>18</sup> is illustrated in Fig 388 As can be seen there was a marked reduction in peripheral blood flow which preceded the fall in blood pressure The rise in hemoglobin concentration occurred only as the blood pressure fell

Clinical methods for measuring the amount of circulation are not available The estimation of peripheral blood flow either by means of the plethysmograph or by the thermo electric stromuhr is not applicable to patients except in research laboratories Determinations of cardiac output either by the Fick principle or by the ballistocardiograph are not readily made Reliance must accordingly be placed upon the clinical signs of reduced circulation as criteria of shock These signs of impaired circulation depend either directly upon the failure of the circulation and the physiological reactions of the body to this condition or upon alteration in the function of various organs produced by failure of the circulation

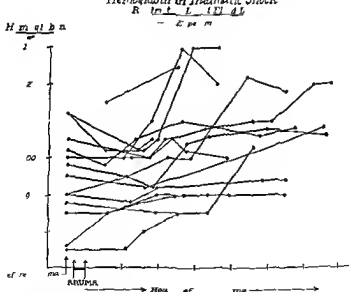
**CLINICAL SIGNS OF REDUCED CIRCULATION**—1 The *character of the pulse* is of great significance in the clinical estimation of the condition of shock Its volume probably gives the single best indication of the general condition of the patient The contrast between the full radial artery which indicates an adequate output of the heart and a weak thready pulse of poor volume differentiates a blood pressure associated with a normal cardiac output from an identical blood pressure maintained by peripheral vasoconstriction in the face of a diminished circulating blood volume

2 The *color and temperature of the skin* are also of diagnostic





### Hemoglobin in Traumatic Shock



Figs 387 d 388—Comp f f t f t d d t ted l cal  
 d d l s s h m g l b t t f d g s f t t m t m t

of fluid into the region of trauma. When the traumatized limbs were bandaged so as to prevent the local loss, hemoconcentration was observed. The effect on the hemoglobin concentration

dehydration the subcutaneous fluid reservoirs are depleted so that the skin when picked up does not spring back into place but remains in folds. The muscles feel doughy to the touch.

4 *Restlessness and disturbances of sensorium* are frequently encountered and are ominous signs of impending failure.

5 *Thirst* is of great significance as a criterion of dehydration shock and hemorrhage unless the electrolytes of the body have been seriously depleted. Under the circumstances even though there is severe dehydration with reduction in plasma volume a condition of thirstlessness without much thirst may be observed.

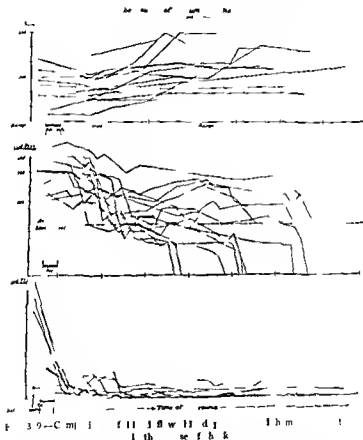
6 *The volume of urine secretion* is frequently of help in following the condition of the patient. As Peters has written: "The patient who is excreting 1000 to 1500 cc. of urine daily is seldom a subject for anxiety."

### RESPONSE TO TREATMENT

The clinical and chemical response to treatment will determine the course of therapy. Frequent measurements of *hematocrit* or *hemoglobin* and *plasma protein concentrations* will show whether or not the circulation is able to dispose of the fluid administered by vein. If both the formed elements and the plasma proteins are being diluted the injected fluid is being retained within the vessels. If the hemoglobin concentration is increasing although the level of plasma proteins is staying constant or even decreasing the fluid administered by vein must be leaving the blood stream and restoration of an effective blood volume cannot be attained. In the presence of increased capillary permeability, whether in a limited region as in case of burns or general as in the shock which follows prolonged inadequate circulation, very large quantities of plasma protein will be required to balance the loss.

Improvement in the *clinical condition* is equally significant. Sustained elevation in blood pressure, retardation of pulse rate and especially improvement in the quality of the pulse are favorable signs. The cessation of sweating, increase of warmth of the extremities and an improvement in color indicate that

importance especially the appearance of the lips the ears the nose and the circumoral region When there is an ashen appearance of the face and the hands are cold and sweaty the process of shock has reached a crisis which demands interven



tion Sweating is naturally absent in the shock associated with dehydration

3 The consistency of the tissues is related not only to the water content but also to the state of the circulation With

dehydration the subcutaneous fluid reservoirs are depleted so that the skin when picked up does not spring back into place but remains in folds. The muscles feel doughy to the touch.

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Improvement in the *clinical condition* is equally significant. Sudden elevation in blood pressure, retardation of pulse rate and especially improvement in the quality of the pulse are favorable signs. The cessation of sweating, increase of warmth of the extremities and an improvement in color indicate that

an adequate circulation is being established. Again it should be emphasized that large quantities of blood plasma or serum are necessary. As Blalock has expressed it: "It is not sufficiently appreciated that the introduction of very large quantities of blood may be necessary in order to accomplish the given purpose. If it is found that 500 cc. of blood is ineffective in maintaining a sustained improvement in the patient, it does not follow necessarily that the use of a larger quantity will not accomplish this purpose."

#### TIME FACTOR IN REPLACEMENT THERAPY

The time factor in the therapy of dehydration and shock is of major importance. Replacement of water, electrolytes, and even plasma and blood is a simple matter before changes in capillary permeability are produced. It is agreed by all, however, that prolonged impairment of circulation causes an increase in capillary permeability. If a state of simple dehydration is allowed to persist, secondary changes take place in the capillaries leading to the loss of plasma protein which will no longer allow recovery with simple replacement of the original fluid lost. When shock is present, even though only water with electrolytes apparently has been lost, restoration cannot be effected by the administration of water with electrolytes alone, since the shock produced by the initial loss of body fluid has occasioned further loss of plasma protein. Restoration of this secondary loss by the injection of plasma is necessary.

*The time factor is also of importance in considering the duration of treatment.* Recovery of normal capillary permeability takes time. Even after the reestablishment of an adequate circulation, the blood vessels which have been damaged either directly by anoxia or by some other physical or chemical agent require time for recovery. The observations of Rhoads, Wolff, and Lee suggest the possibility of reducing this period of impaired capillary permeability by the use of the adrenal cortical hormone. From the standpoint of intravenous fluid therapy, however, the implications are clear. When the factor of increased capillary permeability is added to the initial loss

of body fluids sufficient plasma protein should be administered in addition to the restoration of body fluids to balance the continued loss. The circulation must be maintained until recovery of the capillaries can occur.

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# X RAYS IN MILITARY SURGERY

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C. M. C. U. S. E. S. N. U. S. N. H.  
W. H. N. V. D. C.

In addition to the humanitarian impulse that constitutes a deep activating force in the heart of every true physician and leads him to put forth his best efforts in the behalf of the human wreckage of war, there is another and harsher necessity laid upon him in wartime military service, namely, to keep the maximum number of men in the battle lines. Possibly this fact has been emphasized before, but it will bear repetition for it is properly a fundamental feature of military surgery. Happily the humanitarian and military responsibilities usually go hand in hand, save when in the heat of action it becomes more important to return the slightly injured to battle than to attend to serious cases.

## HISTORICAL DEVELOPMENT

Certain it is that in dealing with the casualties of war and all the various kindred surgical problems of wartime the x ray is a prime essential. Its discovery and utilization was one of the most important milestones in surgical annals and its military importance was promptly recognized. In 1897 successful use of the x ray was accomplished in the Graeco-Turkish war. The British used it on the Indian frontier in 1898 and later, somewhat extensively in the Boer War. In this country at the outbreak of the Spanish-American war the more important Army hospitals and three hospital ships were equipped with x ray apparatus. Seventeen machines were provided in all.

At that time construction was in an elementary stage. Induction coil and static machines were used to activate gas tubes.

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and thereby produce a feeble beam of soft roentgen rays. Batteries were commonly used or occasionally direct current from a dynamo was available either to activate a coil or rotate the plates of a static machine. Radio graphs were made on glass plate and their production was something of an abstruse art worthy of the efforts of a crystal gazer so variable and poorly controlled were the factors. Exposures were enormous—hands one to two minutes, shoulders ten minutes and head, pelvis and spine about twenty minutes. It is remarkable that only a few cases of burns are recorded and also that creditable work including localization was done. Naturally use of roentgen rays near the front line was impossible and in fact decried since it was earnestly felt that its employment there would tempt the more injudicious and overenthusiastic surgeon to attempt premature operation under bad circumstances. And in spite of our vastly improved facilities or perhaps because of them we can still lend an ear to the views with profit and apply our best judgment to the particular problem of how far forward to station roentgenologic units.

When almost two decades later we finally slipped into the vortex of the first World War the military services were not any too well equipped with x-ray facilities as was of course in keeping with the state of unpreparedness generally. Only the larger hospital had roentgenologic units and very few trained roentgenologists were in the active service or reserve corps. Thus a weighty problem had to be dealt with without delay and prodigious efforts were required for its successful solution as may be readily in account by Manges. Suffice it to say that the radiator type of self-rectifying tube was developed, generators were improvised, ambulance roentgenologic units provided and school for roentgenologists and technicians established. In all 719 roentgenologic units were sent abroad—a most creditable record.

#### ROENTGENOLOGIC FACILITIES OF THE NAVY AND ARMY TODAY

As we now prepare ourselves for any eventuality in these troubled days when the clash of arms again fill the world we

find ourselves in a much better situation in regard to roentgenologic personnel and equipment.

In the Navy for a number of years medical officers have been encouraged to specialize in roentgenology and have been given courses in some of our great civilian medical centers. In addition roentgenologists have been enrolled in the reserve corp and are available in case of necessity. Training of technicians likewise has not been neglected. It has been carried out in our major hospitals and in Washington a twenty weeks course is given to men of proper aptitude. In regard to equipment the larger hospitals have full diagnostic facilities and installations for therapy that include 200 kv units. Various smaller hospitals and dispensaries have appropriate installation. Hospital ships have facilities for all but deep roentgen therapy. Most other ships have either some type of mobile unit or a dental unit. In regard to the latter it is surprising what it can accomplish in the way of roentgenography. Suitable equipment is also available for expeditionary units.

In the Army the story is much the same. Its Medical Corps has studied the problem of field equipment with a special thoroughness. In general apparatus for use in the field is now far advanced technically. It is shock and ray proof of adequate capacity, portable, durable, and easy to assemble and disassemble. Processing installations are excellent. One is sorely tempted to dilate further on this matter but space forbid.

#### APPLICATION OF ROENTGENOLOGY TO SURGICAL CONDITIONS

It is only possible to summarize here the subject of the employment of x rays in surgical conditions. In so doing I have in mind more particularly the physicians who are relatively new to roentgenology or its military applications or perhaps to both.

**Fluoroscopy for the Localization and Removal of Foreign Bodies**—Pre-eminent among the surgical conditions incident to war is the presence of foreign bodies. Utilization of x rays for diagnosis, localization and aid in actual removal of foreign bodies is inevitable. The exact procedure will depend on

a variety of factors not the least of which will be limitations imposed by difficult circumstances. At times optimal conditions will prevail and careful roentgenologic studies of any nature desired will be possible. Again circumstances and the urgent pressure of work will impose serious limitations on the roentgenologist. In general a simple method will often suffice and may be all that is practicable.

*Proper Accommodation of the Eyes*—In the performance of fluoroscopy a first essential is proper accommodation of the eyes and regardless of length of experience the roentgenologist must not start work too soon especially when he is confronted with urgent situations. Dark glasses or spectacles kept in readiness for use against sun glare for a preliminary half hour or more are a good investment and will reduce the period in which heavier shielding will be a requisite. Needless to say any tendency to night blindness would render the victim of it a poor fluoroscopist and so the usual dietetic precautions should not be forgotten. The diet may be deficient in vitamin A and this deficiency may be entirely unsuspected.

*Technic of Removal*—In employment of the simplest possible method the operator uses a minimal fluoroscopic field centers the object extends forceps down to it seizes it and removes it. This procedure sounds deceptively simple but in actual practice troubles frequently encountered. Important structures may be in the way or dangerously nearby. In this case especially if the foreign body is jagged it will be advisable to grasp or approximate the object with forceps then direct down to it and to free it safely and expeditiously under good illumination. When such work is being performed it may be an advantage if one member of the operating team keeps his eyes protected during this final stage. In general division of labor will often be desirable. A method found practicable by the French calls for screening immediately prior to operation of patients with retained fragments. Fluoroscopic studies are carried out with the patient in the anteroposterior position. An "A" is marked on the skin over the fragment. Other studies are made with the patient in the lateral position and "L" be-  
n

marked over the fragment. When the patient is on the operating table the letters are scratched on the skin with a needle the field prepared and then removal carried out.

*Determination of Depth*—At times more elaborate means of localization will be called for because of the impossibility of extending forceps directly to a foreign body. Accurate determination of depth will then be needed. The methods employed in general depend on the shift of the image of the object on the fluoroscopic screen or roentgenographic film as the x ray tube is moved. Obviously the closer a foreign body is to the tube the greater will be the shift of its image. Shift of the tube and image anode screen distance and when required shift in terms of angle can be measured. Thus by triangulation the depth of the foreign body can be calculated. If the shift is standardized at a fixed distance or angle depth tables can be prepared or a fixed ratio determined for a convenient anode screen (or film) distance so that on determination of the image shift the depth can be read off or calculated immediately. For additional details of various methods standard reference and current literature are available.

*Radiopaque Objects*—Objects of poor radiopacity are dealt with much easier by roentgenography than by fluoroscopy and careful technique as to roentgenographic density is needed. Stereoscopic is often of aid.

*Foreign Bodies in the Eye*—With the eye special technique and the use of apparatus such as the Sweet localizer or the contact lens localizer (Pfeiffer) will be needed. Difficult cases also bring to mind the fact that it will often be possible under modern conditions to carry out prompt evacuation of casualties by plane to a well equipped base hospital at the rear.

*Protection of Personnel*—It appears worthwhile to mention briefly the matter of protection from x ray even at the risk of seeming unduly elementary. Roentgenologic apparatus has been vastly improved and will stand enormous punishment but there has been no improvement in the resistance of the human skin nor in systemic resistance to the deleterious effects of roentgen ray. Self sacrifice is of course entailed in war but by

care this can be minimized. Moreover a technician, surgeon or roentgenologist who himself becomes a casualty loses his usefulness and constitutes a liability.

Precautions are essential. The use of diaphragms to obtain the minimal field practicable gives sharper definition and reduces exposure. The hand should be protected by gloves when the conventional heavy gloves are impracticable; even light gloves will afford some protection. The hands should be kept out of the direct beam—the patient's body should always intervene. Other factors are strictest economy in the time the roentgenologic unit is in operation, aluminum filtration, tests as to degree of exposure by the wearing of dental films, checks on the blood count, good ventilation of the fluoroscopic room and good personal hygiene. In this way much painful and often unnecessary damage can be avoided. Unwary individuals still are falling victims to roentgen rays.

### X RAYS IN FRACTURES AND DISLOCATIONS

A second huge class of surgical conditions in which roentgenology is a prime essential is comprised of fractures and dislocations. Both roentgenography and fluoroscopy are needed but in diagnosis it should never be forgotten that the roentgenogram will reveal more than the fluoroscopic screen and moreover provide a permanent record which can be given meticulous scrutiny. In diagnosis of bone condition, fluoroscopy is a deceptive short cut fraught with peril and likely to entail more trouble than it will save. Also it will occasion more personal exposure to roentgen rays which is an important consideration.

**Reduction under Fluoroscopic Control**—Reduction of fractures under fluoroscopic control is often favored and at times necessary. The ever increasing use of such appliances as the Roger Anderson apparatus to obtain and maintain reduction will tend to increase the amount of fluoroscopy. It is not at all necessary, however, no matter what the volume of work, to receive excessive exposure. Several millimeteers of aluminum filtration can be used and by intelligent planning and use of good judgment a very small amount of fluoroscopic exposure will

accomplish all that is necessary. On the other hand, with carelessness and a heavy foot on the switch, damage can result from only a few exposures. When reduction is accomplished the end result should by all means be checked roentgenographically.

**Obscure Fractures in Extremities**—A complete summary of fractures is of course impossible and it appears best to touch on some aspects which though apparently minor cause much trouble. Injuries to the extremities are of great frequency and all too frequently are attended with undetected fractures which through neglect occasion heavy disability and loss of time. Notable in the group is *fracture of the carpal navicular* which as often as not fails to be promptly recognized either through failure to make roentgenograms or failure to employ adequate technic. The results are deplorable particularly in military service. The wrist weakened and painful due to non-union of this bone distinctly limits usefulness of the patient and may keep him on the sick list for months no less surely than a formidable injury that compels attention such as a fractured femur. Because of the peculiar curvature of the navicular some modification of conventional technic such as turning the wrist laterally toward the ulnar aspect or turning the central ray upward at an angle toward the elbow or taking an additional view with the wrist in a slightly oblique position usually will be desirable.

Other injuries likely to be missed are damage to other carpal fractures of the various tarsal and metatarsal bones fractures of the intercondylar eminence of the tibia fractures of the condyloid and coronoid processes of the mandible fractures of the facial bones particularly the zygomatic and compression fractures of the vertebral bodies. On the other side of the picture care must be taken in diagnosing as fractures such conditions as bifid sesamoid accessory ossicles or growth centers ununited epiphyses or apophyses line due to overlapping bone or even soft tissue margins and various artefacts and anomalies.

**Fractures of Skull**—Skull injuries are grave but there is

practically never any occasion to rush a patient who is in a state of shock or possibly *thresun* about in delirium into the x ray room to determine the matter of possible skull fracture. Fortunately this overpreoccupation with damage to the cranial vault is passing away and less and less of this particular manifestation of poor judgment is encountered. None the less it is worth mentioning because it is most important because many of us still worry too much about the skull itself and finally because we have to withstand pressure from lay people who do not understand the situation in the slightest way and almost invariably believe that it is a matter of life or death to determine at once if fracture is present.

**Other Conditions in Bones and Joints**—In the natural concern with foreign bodies and fractures we must not lose sight of other conditions of the bones and joints. They continually obtrude themselves on us and occasion numerous vexatious problems. Among these problem complaints referable to the spinal column and extremities are well to the fore. Serious disabilities must be detected from the minor the exaggerated and now and then the simulated. In making these distinctions roentgen rays are of course indispensable only thus will we sift out conditions such as Pott's disease or osteochondrosis or osteochondritis dissecans the para arthritides such as peritendinitis or bursitis serious sacro-iliac trouble spondylolisthesis retrodisplacement of the fifth lumbar vertebra various anomalies arthritis and bone tumors from the innumerable cases of mere strains sprains and the like with which we are likely to deal summarily. It is of course impossible to examine roentgenologically every minor case of trauma but common sense dictates that when pain and disability persist unduly x ray should be called for. Otherwise grave and humiliating results may be forthcoming.

#### ROENTGEN THERAPY

Roentgen therapy an important adjunct to surgery. In wartime service *furuncles carbuncles* and *cellulitis* occur at least as frequently as in civil life and roentgen rays usually are of great benefit particularly if used early. When these infec-

tions involve the face roentgen rays may be life saving. Gas gangrene also is greatly benefited. Large dosage and heavy filtration are not essential to good results and accordingly the lightest type of apparatus such as a dental unit can be utilized in emergencies. A word of caution is necessary about its use however. Although it is surely permissible to use such a unit for severe infections it would be folly to use it for the innumerable cases of fungoid infections acne and others such abuse would soon ruin the unit. Treatment of numerous cases calls for fairly sturdy apparatus.

Another group of frequently encountered infections that is greatly benefited by roentgen rays is comprised of *infections of the middle ear and mastoid process*. My experience at the Naval Hospital in Washington extending over one year indicates extremely good results and a marked drop in cases that require operations. Inasmuch as low or moderate dosage will nearly always suffice the use of roentgen rays is not completely interdicted if one of the sulfonamide drugs is being given. Heavy dosage should of course be avoided and those physicians referring such cases for treatment should inform the roentgenologist of the use of these medications and the dosages employed.

As a final word on treatment it might be mentioned that splendid results are obtained by the use of roentgen therapy in many cases of so called *subdeltoid bursitis* and kindred conditions that so often prove resistant to usual measures. Also good results are occasionally obtained in cases of severe *strains* and *sprains* that have likewise proved unduly resistant to treatment.

#### PHOTOFLUOROGRAPHY

Units for photofluorography (photoroentgenography) have been developed in the Navy following the lead of Dr. De Abreu of Brazil<sup>11</sup> chiefly for chest surveys. Improvements and refinements as to technic and material have made possible excellent results. Thoracic examinations of all recruits are made by means of this method. In addition experiments indicate that further expansion of its field of usefulness may be ex-



pected. Excellent views of bony structures can be made and such thing as survey of hands and feet may become practical at a minor cost in addition to a certain amount of routine work.

Another innovation still in the experimental stage is the application of *lenticulated film* to photoroentgenography. By this method it is possible to obtain stereoscopic depth perception on a single film and it is hoped accurate depth measurements as well. If the method should prove practicable its value to military surgery is obvious. We expect to acquire an experimental unit for this type of work in the near future.

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# AVIATION MEDICINE

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AVIATION Medicine is a development of the first World War. It is an inclusive specialty which may be broadly regarded as the application of the medical and allied professions to the problems of the physical and psychogenic stresses encountered in flying. For many years its field of activity was largely restricted to military aviation but in more recent years it has been extended to apply to civil aviation as well.

There are many physicians whose contact with aviation is limited and who are unacquainted with many of the problems encountered in flying. For these reasons the object of this paper is to present a general picture relating to the subject of aviation medicine as a specialty, its function and the importance it is required to play in the present emergency but without attempt at detailed discussion of the technical problems encountered in flying.

## HISTORICAL DEVELOPMENT

Early in the first World War pilots were poorly selected with regard to their physical and psychological fitness for flying. Little was known concerning the stresses peculiar to flying, and physical standards were inadequate and poorly adapted to the requirements of aviation. For quite some time the principal criteria of fitness for flying consisted largely of the individual's

This paper is set forth here in the form of a lecture given at the Department of the Air Force, U. S. Army, Washington, D. C., in 1933.

willin<sub>g</sub>ness to en<sub>g</sub>age in this hazardous vocation. There were no special provisions to protect pilots from carbon monoxide poisoning due to motor exhaust from anoxia at hi<sub>g</sub>h altitudes from extreme cold noise vibration and glare. There were no special provisions or trained personnel for the detection of accumulative fatigue staleness or be<sub>g</sub>inning neuroses among pilots who showed evidence of deterioration. The results were soon disastrous. Casualties due to crashes increased. Pilots became inefficient and were lost. The neuroses and functional disturbances increased and even students under instruction developed a high percentage of functional nervous disorders. This resulted in increased failures to qualify in flying and increased numbers of crashes while pilots were under instruction.

This situation resulted in the first Special Care of the Flyer Service consisting of medical officers who devoted their particular attention to the problems described above. Special training was introduced to qualify medical officers to carry out these duties. From this be<sub>g</sub>inning was evolved the specialty of aviation medicine and with it the name Flight Surgeon for those en<sub>g</sub>aged in this work.

Coincident with the development intensive research was undertaken to acquire more information concerning the effects of anoxia on the organism and explore the role of the *cardio-respiratory system* in flying especially at hi<sub>g</sub>h altitudes. Studies were applied to *equilibrium* and the internal ear. The importance of *acid-base balance* and the buffets at hi<sub>g</sub>h altitudes under condition of anoxia was carefully appraised. The *physiologic standards* for flying were completely revised. *Oxygen supply apparatus* for use at hi<sub>g</sub>h altitudes was developed and made available. Of equal importance was the timely appreciation of the *psychologic stresses* involved and measures for dealing with this problem.

During the past twenty years the knowledge thus gained has been applied with some advancements but systematic and planned research has lagged terribly. We have improved our standard of selection and we have applied this knowledge to the need of civil aviation as well as to those of the military.

services but we have not kept pace with the new and increased stresses brought about by advancements in aeronautical engineering and design.

During the first World War planes were slow the rates of climb were slow and ascents seldom exceeded 15 000 to 18 000 feet. Today planes often exceed 400 miles per hour in speed. Fighter planes come over at 30 000 to 35 000 feet. Some planes climb at the rate of about 5000 feet a minute. Certain planes have multiple motors and carry large crews and have a cruising range of over 5000 miles. Therefore *flying stress* has increased. For instance the oxygen problem is far more complex. Old oxygen apparatus and indoctrination are now inadequate and must be completely changed to meet the requirements of extreme altitudes. High altitude flights and rapid climb have introduced the new problem of bends or *acrobolism*. The cold encountered is more severe and the gravitational stresses encountered in certain aerial maneuver are accentuated. As a result of the latter condition the circulation is subjected to such gravity stress that temporary blindness is produced—the so called *blackout*. This is most important in combat flying and dive bombing. Experience gained in the present war reveals the importance of special tests for evaluating *dark adaptation*. The importance of adequate efficiency in dark adaptation is readily appreciated when we consider the extent of night flight operations now being carried on. The truth is the performance of the modern advanced military plane has come to exceed that of the pilot and one of our pressing needs is to devise means of enabling the pilot to catch up with his plane's performance and keep abreast of its further advancements.

Aside from the physiological research required to meet the advancing demands of modern aviation the Flight Surgeon has a most important role to play in the application of our present knowledge of aviation medicine to the needs of flying as they now exist. This function may be roughly divided into

1. Selection of Flying Personnel
2. Supervision and Control of Flying Personnel

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## SELECTION OF FLYING PERSONNEL

**Physical Standards**—With regard to pilot election undoubtedly the physical standard for flying in our military services are the most exacting of all countries. Particular emphasis is placed upon *visual function* and the *cardiovascular system*. Military pilots are not only required to have normal visual function but they are also carefully examined for evidence of any latent defects which under the stress of flying anoxia fatigue and so on might become accentuated and therefore manifest. For this reason the eyes are refracted under a cycloplegic. The true correction is determined and the eyegrounds are carefully explored. The color vision and the peripheral fields of vision are subject to special examination. The extrinsic muscle balance of the eyes is measured on a phorometer for evidence of any excessive phoria. Stereoscopic vision is measured as also the accommodative power and the angle of convergence. This whole array of data is then correlated to fit into an inclusive picture that insures good visual function with adequate reserve.

Without further regard to the detail of the examination for flying it is sufficient to say that a Flight Surgeon or Aviation Medical Examiner must have a practical working knowledge of certain aspects of the specialties of ophthalmology otolaryngology cardiology and psychiatry as well as the basic groundings of the general profession.

**Basic Stability and Aptitude**—While we have been able to conduct an excellent examination on the basis of purely physical criteria this phase of selection alone is of only limited value. The foremost problem today in selection has to do with the evaluation of an individual's basic stability and aptitude for flying. This is a most involved problem. Many individuals who may be regarded as basically stable may possess a poor aptitude for flying. The effort to develop a method of psychological and psychiatric examination whereby only the good risks are retained and the poor risks are excluded has thus far met with only limited success. At present the final test is a try at actual flight training where success or failure under

actual flight instruction is the deciding factor. Where thousands are to receive flight training any large percentage of failures constitutes a serious problem in wasted time and expense and call for most careful selection. However this matter is receiving intensive study and the outlook for improvement is encouraging.

Selection of applicants for flying is an important link in our pilot training program and requires the services of a large number of Aviation Medical Examiners especially trained to properly conduct the examinations.

### SUPERVISION AND CARE OF FLYING PERSONNEL

Returning now to the care of the pilot it is clear that we are dealing with a highly selected group engaged in a hazardous vocation. These individuals are actively engaged in a profession which requires constant vigilance and a high degree of perfection in the performance of their duties. It must be clear that even among those pilots of unquestionable skill and maximum adjustment there are always at play the latent *apprehensions of danger*. As Armstrong has expressed it: Apprehension, anxiety and fear are simply three stages of comprehension of danger and it is common knowledge that each results in profound nervous and mental depletion. Therefore it is not unreasonable to appreciate some limit in flying time beyond which the most stable person will show evidence of deterioration. This limit varies with the individual and considerably so depending upon the nature of the flying performed. Generally speaking about eighty-five hours in a month is considered as a generous task.

**Pilot Fatigue or Staleness**—As previously stated military aircraft are now so advanced that actually they can exceed in performance the capacity of the human element. The stresses to which the pilot may be subjected are great. When we take into consideration the effect of prolonged noise, vibration, glare and extreme cold and add to this the emotional stress accompanying such flights we have an explanation for



the first condition frequently to be encountered among aviators namely fatigue

Fatigue as used here does not refer to strictly physical fatigue as normally regarded but to that condition commonly occurring among normal healthy pilots as a result of flying stress. It is primarily *neurogenic* and rapidly tends to become *accumulative*. It is not measured in diminished capacity to do work but rather in the diminished will to work. These individuals do not recover their forces in the course of the average rest periods. They are tired on awakening their morale suffers they cease to be alert and they suffer indifference to details. In the course of time they become inefficient and dangerous in their flying. If neglected the picture progresses to profound staleness and in their effort to carry on in the face of a growing sense of inadequacy the syndrome may merge into a *neurosis*.

These patients when detected in time promptly respond to physical rest and reasonable relief from flying. Their basic usefulness and attitude toward flying are not permanently impaired.

However when a case of accumulative fatigue or staleness is neglected or permitted to progress to the point of an established neurosis or the pilot has lost his efficiency and confidence as the result of a prolonged anxiety state he has usually gone too far for prompt response to treatment and his loss to the flying service is protracted and often permanent.

The early manifestations of pilot fatigue or staleness are almost invariably subclinical and easily pass detection. The pilot does not appreciate his condition and under the circumstance the syndrome may easily progress to the point where relief from flying becomes necessary and protracted. The insidiousness of the onset and circumstances attending the picture described are such that the average clinician of little value in detecting these cases.

**Functions of the Flight Surgeon**—Experience has shown that in order to establish an early diagnosis of staleness and institute corrective measures it is essential that the attending

medical officer shall have a thorough first hand appreciation of the types of stress both physical and emotional that the pilot is subjected to. Furthermore and of equal importance the medical officer must know intimately the pilots under his supervision. He must be familiar with their private and domestic problems as well as their professional ones for emotional stress may and often does arise from these outside sources. The medical officer must be thoroughly familiar with the personality of each pilot his normal emotional and social tempo and when trouble develops the first indications are minor and insidious changes in these attributes.

We may say therefore that an important function of the Flight Surgeon is in a special field of preventive medicine in which psychiatry is the principal guide. There are other important functions such as the care of the ears the maintenance of physical fitness oxygen indoctrination routine care of the sick field supervision and studies directed to the improvement of pilot comfort and efficiency.

**Facilities for the Training of Flight Surgeons and Aviation Medical Examiners**—To provide these means of trained medical supervision and to qualify officers as Aviation Medical Examiners both the Army and the Navy operate service schools devoted to the training of medical officers in the specialty of aviation medicine. The subjects stressed in these schools are ophthalmology otology physiology as applied to aviation cardiology psychiatry and psychology. Laboratory and practical instruction is emphasized. In the Navy the course of instruction is extended to include two months of indoctrinal flight training in which the student may be permitted to solo. During this phase of training the student engages in formation flying blind flying catapult shots and torpedo runs. The object is to acquaint him at first hand with the different experiences normally to be encountered in flying. This combined training leads to the designation of Flight Surgeon Officers who complete only the course in aviation medicine but do not take the flight indoctrinal training receive the designation of Aviation Medical Examiner. In the Army the sys-

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tem of training is slightly different in that following the course of academic instruction in aviation medicine the medical officer does not receive his designation as Flight Surgeon until he has served a year with the air forces during which time he acquires his flying experience.

As can be seen the object is to place medical personnel especially trained and with first hand knowledge of the stresses encountered in flying in close contact with flying personnel. Experience indicates that only by such means are we able to render the best service to our air forces.

#### AVIATION MEDICINE IN COMMERCIAL AVIATION

It would not be proper to conclude this subject without further reference to aviation medicine as applied to commercial aviation. The role is similar to that for the military services. The Civil Aeronautics Administration has established physical standards for civilian pilots. These vary with the nature of the flying to be performed. Accredited medical examiners conduct these examinations which are mandatory. In addition to these measures all commercial airlines have their own medical directors who establish such additional physical requirements as may be considered necessary by their company. These airline medical directors and their staffs have made valuable contributions in the field of aviation medicine. It is to them great credit is due for many of the medical safeguards and advancements directed to improving passenger comfort in flying.

#### CONCLUSIONS

From the foregoing it will be seen that in time of war or in the event of further extension of our national emergency physicians with special training in ophthalmology or psychiatry would be easily adapted to a role in aviation medicine. While these two specialties are not the sole requisite for this type of duty they do comprise an active field. Probably one of the most outstanding requirements for this work is the personality of the physician. To be a successful Flight Surgeon one must be able to convey and invite confidence. Unless the Flight Sur-

geon can make himself trusted and liked by his pilots his usefulness is virtually nil except possibly as an Aviation Examiner

Inasmuch as aeronautical performance is constantly progressing the need for *physiological research* is most essential as a counterpart This is a field within itself While these studies are intimately related to aviation medicine they are not subject to any limitations The National Research Council is rendering valuable assistance at this time to the aeronautical services as are many scientific institutions and individuals The need for these studies is pressing We are awaiting many answers We have not reached the limits of flying performance and the future has much in store for us At the present time it may be said that further progress in aircraft performance will be of limited value until we can relieve the limitations now confronting the human element



# MILITARY DENTAL SURGERY

ROY A. STOUT D.D.S.

LIEUT. COL. DENNIS A. W. P.  
GEORGE H. F. L. W. HEN. D.C.

## THE MISSION OF THE DENTAL OFFICER AND DENTAL CORPS

The primary mission of the dental officer in the Army is to correct and maintain the oral health of the military personnel. Two important factors in this mission however greatly alter its fulfillment in comparison with similar professional objectives in civil practice.

First the dental surgeon is a Medical Department officer and participate in the general mission of the Medical Department. In common with the medical officer he shares in the general medical functions of training in the broad administrative organization and finally he may participate in many and various medical activities as an auxiliary medical officer.

Secondly dental surgery in the military service draws the dental officer closer to medical and surgical practice both in the dental field and in their general aspects than is experienced by the civilian dental surgeon in civil practice. The organization of Army medical installations for war places the dental officer as an integral part of each medical military unit. In the training of the personnel of these units to serve combat troops dental officers must complete an intensive training routine covering the early care of gunshot wounds gas casualties and the great variety of disabilities occurring on the battlefield. He must be trained to assist medical officers in the first aid station casualty clearing stations and hospital units.

The purpose of this dental health publication is to assist the dental officer in the military service in the performance of his duties.



Furthermore the dental officer must be able to replace medical officers who may become casualties until medical replacements arrive.

Even the primary mission of the Dental Corps expands and moves directly into the field of surgery. Confronted with one of the greatest problems of the Medical Department the dental officers must clear every mouth of diseased teeth and the universally recognized sources of infection—dental foci. In the routine examination of the thousand of cases treated daily in Army hospitals close comparison of observations with the pathologists and intelligent differential appraisal are both necessary to the rendering of final diagnoses. These relations vividly developed and thoroughly understood make possible a useful and important service in every military hospital.

#### DENTAL AND ORAL DISEASE

The approach to surgery may be in the Oral Surgery Service of the military hospital with its elaborate equipment, nurses and other trained personnel. The dental surgeon on duty here may be solely under the supervision of the Chief of Oral Surgery or he may be under the direction of the Chief of Surgery. The conditions encountered may be of major consideration such as osteosarcoma and carcinoma requiring operative treatment in the surgical pavilion. In the care of these dental lesions and of involvement of oral tissue the dental surgeon, carefully trained and displaying surgical discernment and intelligent skill, fills an important place in the Medical Department.

The training and experience of the military dental surgeon approach in scope the training and experience of his brother medical officer in respect to the necessary medical care of the large and varied group of cases under his care. In fact his training often places him in a much better position to determine both the medical and surgical care of purely dental cases. The newer methods for the treatment of local and general infections are applied with brilliant results in oral infections. The dental surgeon becomes particularly interested in the treatment of the more serious jaw infections concerning which

he has frequent consultations with the surgical and medical services. In the more serious infections involving the head and neck the dental surgeons may be relied upon to aid and assist the military surgeons in their treatment. Working together they will try to avoid surgical procedures which might seriously interfere with the normal functions of the dental structures or cause the disfigurement of facial tissues.

With this advanced and improved status of the dental surgeon in the military organization it is obvious that his approach to the more common and universal problems of tooth removal, eradication of diseased oral tissue and periodontal involvement is more likely to be in keeping with sound surgical principles than it might otherwise be. The more desirable methods of surgical removal of teeth and surgical preparation of the mouth for prosthesis not only simplify difficult extractions and conserve tissues but provide for shaping and forming of the ridges for the reception of satisfactory dentures. In other words the dental surgeon receives a type of instruction under the Army training program and in accordance with sound surgical judgment that enables him to construct the highest type of prosthetic replacements for the restoration of function.

The tissues adjacent to the dental structures unfortunately are susceptible to inflammatory processes to an astounding degree due to faulty care or mutilation of the natural dentition through malocclusion, neglect or early loss of individual teeth. The various forms of gingivitis, traumatic occlusion, infections and loss of the vertical dimension of the dental apparatus are but a few of the conditions which affect the dental structures. An acute disturbance may yield to simple measures of treatment. More frequently the continued irritation of infection leads to a chronic involvement and to the loss of investing soft tissues with disintegration of the bony supporting tissues and loss of the teeth themselves.

The dental surgeon must recognize these conditions and initiate the treatment indicated for their elimination. The surgical procedures when indicated offer a satisfactory solution in many such cases making possible the retention of many

teeth which might otherwise be sacrificed. These are important considerations in the maintenance of the oral health of the military personnel.

### RESTORATIVE DENTISTRY

In a great mobilization and training program for national defense much attention is devoted to the training of dental officers for the purely technical operations of restorative dentistry and for the many aspects of dental surgery. The training programs lead far into the fields of first aid for battle casualties and the particular and essential care required for jaw casualties. In this training in the dental field especially and in the larger field as auxiliary medical officers the instruction and varied training schedules draw the dental surgeon close to the medical officer in his contacts and responsibilities.

It is perhaps in the Maxillofacial Service that dental and medical officers are in closest relationship having here many mutual problems in respect to training and ultimate duties. Refresher courses in plastic and maxillofacial surgery are provided for the special training of selected personnel of the Medical and Dental Corps. The objective and purpose of this instruction is to form and provide *maxillofacial teams* trained for this specific surgical service. These skillful dental and general surgeons will be qualified to institute the highly developed type of surgical care required to restore the facial tissues and dental function following injuries and gunshot wounds of the face and jaws.

A knowledge of urgent first aid measures, a recognition of the necessity of the rapid application of basic principles in early treatment and a profound understanding of the common problems in every jaw wound are essentials for both medical and dental officers. Beyond this is the dominant responsibility of those charged with the care of the wounded to save life and restore those men who bear the scars of war to society and lives of usefulness. The end results in reconstructive maxillofacial surgery are directly in proportion to the type of first aid treatment and early care rendered by dental personnel in the

combat units and by the maxillofacial teams supporting them in the hospital installations to the rear

All dental officers receive training in the care of jaw casualties and all medical officers and enlisted men with the medical units of the combat organizations are taught first aid measures for jaw casualties. With the development of the great training program in the Dental Corps in event of war we should be as confident of proper care and proper first aid treatment of jaw casualties as we are of the proper application of a Thomas splint in the first aid station or casualty clearing station.

Dental surgery is directly and firmly associated with the medico-military organization. Its progress since World War I and its full development within the Medical Department have given it stature and enhanced its value, bringing a recognition of its important contribution to the highly developed medical team essential for our Army.



# INDEX TO VOLUMES 19 20 and 21

(1939 1940 and 1941)\*

## SYMPOSIA

### 1939

F b (Ch ca )	O	S						
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O i b (t L )	C			P	M	Su		D
D mb (Ph l d lph )	T				F	C		L
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### 1941

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Ap l (N Y k)	TR			S				
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I (M y Cl )	S			T	M		C	
O i b (Cl l d Cl )	H				M			
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A									
mlt	1605								
ppc	1947	J							
d	1741	D							
h	289								
Γ b	10 4								
I t	88								
A g	10 4								
h	88								
t	973								
m t									
A									

Abd									
b l m									
p									
d g									
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 Al h l m h g th py  
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 Alkal hld 1940 Oct 151  
 All rrv r tabl col d 1939 O t  
 114  
 A b l l 1940 O t 1549  
 A t b 1939 D 1494  
 A put t g d 1940 t b 8  
 A lase bl and t m t g 1940  
 Oct 12 8  
 Amyl d t m f l 1940 J  
 16  
 An b feet 1939 D 1391  
 k h py 1940 A g 1138  
 An pla 1941 A g 949  
 And son amb l ry t f h  
 m thod f t f f m l  
 ft 1940 D 1753  
 A l g hype t b l m d t  
 1941 Oct 1248  
 f ct on l t bleed g 1941  
 Oct 1448  
 A m th bl t l lt  
 1941 J 678  
 f ll g pl t y 1941 Ap l  
 464  
 h m l t pl t m 1941  
 O t 1453  
 ca f l 1939 O t  
 1159  
 h l t lt 1939  
 Oct 1157  
 d we se f l 1939 O t 1157  
 A th ca d l p d l 1939  
 D 1516  
 f b l m l p t p lm  
 c mpl cat d 1940 A g  
 98  
 for ect l g y 1940 A g  
 926 10 9  
 f bl ry t c g y g d  
 1940 F b 50  
 f l b t p t t 1940 A  
 1182  
 f f ct ed t 1941 F b  
 207  
 f k t g y 1941 J 803  
 f t t l g d 1940  
 J b 16 20  
 l pe t fi t f f m k  
 f t l 1940 F b 80  
 1191 k 1940 A g 1053  
 f t d t 1939 Ap l 506  
 f thy l k y 1941 O t 1265  
 432 43 g y 1940 Ap l  
 b ee h p t t 1939 F b  
 261

A th l t d w l 1939  
 D c 1352  
 N l p a t 1941 D 1545  
 t N l p t  
 1941 D 1554  
 l x l 1941 l l 277  
 f l pe t 1939 D c  
 1513  
 f th l k 1941 O t  
 1267  
 f t fl ct my 1939 J 825  
 N l p t 1941 l  
 1551  
 p l m y l t 1940 Ju  
 621 A g 917  
 t d 1939 A k 1053  
 g l 1941 l l 77  
 f pera k 1939  
 J 583  
 N l p 1941 D  
 1551  
 A l l See Sp l ll  
 A th t g t f t ll g  
 h 1940 A g 915  
 A y m t b h g ca  
 m d 1940 t b 167  
 A t t t 1939  
 A g 981  
 A g L d b 1941 F b 62  
 p t g t t l y t m  
 d 1941 J 773  
 A k m 1939 Ap l 465  
 fl 1941 A g 904  
 fl c 1941 F b 73  
 A hyd m ppe d t 1939  
 Ap t 29  
 A kl b t l ficat b t  
 1941 Ap l 511  
 th d 1939 F b 133 J  
 715  
 block h 1941 F l 292  
 f t b t 1939 D 1455  
 1940 D l 99  
 p 1939 F b 13  
 p 1941 Ap l 525  
 tht 1940 Oct 1447  
 A kyl bl ph p m t  
 1940 Ap l 584  
 A t f i t l p t pe t p k  
 g l 1940 A g 1084  
 g p d p pe t ca  
 1940 A g 1077  
 A f p g y 1940 F b  
 26  
 A m g th py 1940  
 A g 1107  
 A py th d 1941  
 O 1309  
 A pt m l ry g ry 1941  
 D c 1529



Abd m pe l t tag  
mb rd 1939 A g 1011  
1941 V g 1134  
t t g (Lah) 1939 J  
657  
M t h l l t m 1940  
F b 256 261  
h pe l ca f 1941  
F b 299  
M f k h ld 1941  
Ap l 536  
Al c ppe d t 1940 O t  
1262 1324  
B h t 1939 V g 10 8 1941  
F b 91  
ll l t 1940 O 1466  
f t 1941 l b 4  
f k d y 1941 D 1641 1641  
f l 1940 F b 47 Oct 1243  
f l g 1939 J 8 l 1940 O t  
148 1941 D 1601  
l be t my f 1941 Ap l 605  
f al c p 1941 F b 26  
p l 1939 Ap l 42 1941 F b  
93  
pe ph t 1940 Ap l 309  
1941 D 1645  
p l 1939 Ap l 4 3  
p l l 1940 Ap l 5 7 1941  
F b 9  
f h l 1939 l l 19 V k  
10 v 1941 Dec 1658  
f h g m l 1940 Ap l 563  
f o 1939 F l 19 1941  
Dec 1656  
f pl g l 1940 Ap l 561  
ph l 1941 l b 30  
h t l 1940 O 1467  
bh pa 1939 Ap l 433  
bm ll ry 1940 Ap l 56  
bph 193 Ap l 435  
h l 1940 O t 1458  
Aca dm b l ry  
g v 1940 A g 1009  
d hock 1939 Dec 137  
1941 D 16 4  
V t b l p f t p l  
1940 J 863  
A h l l e t d pe  
f t l pa l 193 F l 13  
A d y pep l 1941  
J 66  
V m 1940 J 654  
1941 J 906 V 929  
t m 1939 O 12 5  
A f l a ry p l 40  
Ap l 4 l  
V g ly h p l l  
J H O 1245  
Ac mocl l d loc l 40  
Dec 1618

A my f b ea t 1941 F b  
77  
f k 1941 F b 61  
Ad m t m f j 1941 V g  
1022  
Ad c ma d t m typ  
1941 V g 10 l  
f k l 1940 Ap l 411 1941  
A k 11 4  
f h d gl d 1941 A 1042  
f t 1939 O t 1317  
Ad fl m f b t 1941 F b 68  
V l l m 1941 F b 32  
Ad l h pe t phy 1941 F l 31  
Ad l gn f th d gland  
1941 A g 1045  
f l l 1941 A k 1164  
f b a 1941 F l 67  
f h d gla d g d d l p  
m t 1941 Oct 1334  
Ad p t ry 1940 J 654  
659 1941 l 909  
A l tos f l 1939 Oct  
1135  
Adh tes l bstru t d  
1941 Dec 1612  
Ad l gl d t cal t t  
d hock 1941 Dec 1640  
m 1941 V g 1163  
cal h perf  
1941 A g 1166 O t 1246  
m d l l h perf  
1941 A 1164  
A t hol m 1941 Dec 1795  
A o ph b l h l j  
1941 Apr l 314 3 0  
A t m l 1940 A k 1114  
Af m g h d l b 1939  
F l 253 2 8  
Ag h f h d 1940  
A g 919  
Ag d ry f l p oc f es  
1940 F l 11  
m g p oc l 1940 F b  
4  
J d d ca  
1940 F b 3  
po m 1940 F l l  
A m f pe t d  
1939 Dec 13 9  
A Co p pers l elee 1941  
D l 96  
pe d 1941 Dec  
1797  
Al l l j b l e  
1940 Ap l 539  
bl pa 1939 Dec  
1569  
p 193 J 689  
J g m l f g 1940  
663

Al h l j t f 1939	A tl l t dw d 1939
D 15 0	D 1359
Alcoh l m h 1940 A h 1140	N l p t 1941 D 1545
Alkalos h l 1940 O t 1512	t 1941 D 1 4
All rgy rrt bl col 1939 O t	local 1941 f l 277
114	f l p t 1939 D
Am b f l 1940 O t 1549	1513
Am t b 1939 l c 1494	f th l g y 1941 O t
Amp t t g d 1940 f b 8	1267
Am l se bl l m t g 1940	f t llect my 1939 J 825
Oct 1258	N l p t 1941 D
Amyl l t m f l y 1940 J	1551
706	p l y lcat 1940 J
A b f t 1939 D c 1391	621 A g 917
g th py 1940 A g 1138	t l 1939 A g 1053
An pl 1941 A g 949	g l 1941 f b 277 k 1939
And so ml l t y t f	f p t 583
m hnd f f f m l	J l p t 1941 D
h f 1940 Dec 1753	1551
And g hypc m t l d t	A p l s sp l th g
1941 O t 1748	l th t 1940 A g 915
f t l t l l g 1941	A l m t b l g ca
O t 1448	m d 1940 F b 167
A mia th f l t l l	t m t 1939
1940 J 678	A a 981
f l g pl 1941 Ap l	A g L d g 1941 F b 62
464	A g t d 1941 J 7 3
h m l t pl 1941	A b m 1939 Ap l 465
O t 1453	f b 1941 A g 994
ca m f l 1939 O t	of b 1941 f b 73
1159	A h d ppe d t 1939
h l t l 1939	Ap l 295
O t 1157	A kl b cal ficat b t
d u f l 1939 O 1157	1941 Ap l 511
A th ca d l p l l 1939	h od 1939 F b 133 J
D 1516	715
f bd m l p t p lm	block h 1941 F l 292
mplcat d 1940 A g	f ct l 1939 D 1455
98	1940 D 1799
f l g 1940 A g	p t f t l p ly
926 1079	p l 39 F l 132
f bl t k g l	p 1941 Ap l 525
1940 F b 50	hl 1940 O t 1447
f l l t p t t 1940 A	A kyt bl ph po t t m t
1182	1940 Ap l 584
f f d 1941 F l	A ct l f t l po t pera p k
207	g f 1940 A g 1084
f g t g 1941 J 803	K p Jp pe t ca
f t l 16 20 f f m k	1940 A g 1077
f l 1941 f f 90	A f p g y 1940 F b
f l 1940 A g 1053	26
f l g 1940 Ap l 506	A A g 1107 g th p 1940
1191	A t p t thy d 1941
f t l 1941 O 1265	O 1309
f h l g 1940 Ap l	A cept l t y g y 1941
f l h 193 F l	D 1529
432 435	
l h p u	
261	

- A t e p t e s k 1940 A g 932  
 ry 1940 Ap 1 419 499  
 d 1939 D c 1363  
 A t m t cal 1939 Oct  
 1243  
 A t m m l g t t m 1941  
 A g 1011 1021  
 A 1940 Ap 1 503  
 l j ry 1941 April 447  
 An ca m 1941 A g 1179  
 d m p l c o g t l 1939 A g 1032  
 f i s s f f i t t h 1939 A g  
 10 4  
 p a local h e s s a f  
 1939 D c 1513  
 p l p s e 1940 J 8 9  
 p r u u l c o h l j e c t f 1939  
 J 689  
 e f i t t 1939 A g 10 1  
 A p p e d e t m 1940 Oct 12 6  
 d f 1939 Ap 1 369 385  
 395  
 l h i a f l l g 1939  
 Ap 1 372 449  
 h a m m 1939 April 368  
 m h i a f l l e t  
 p e l p a r a f 1939  
 Ap 1 453  
 M B r n 1939 Ap 1  
 367 449 450  
 p f e d i e c h 1939  
 Ap 1 367  
 e c 1939 Ap 1 368 449  
 p l h f 1939 Ap 1  
 353  
 A p p e d l b s e e 1940 O t 126  
 1328  
 c o l 1939 April 281  
 A p p e d t 1940 J 731  
 O c 1261  
 t m s e t l m p h d  
 m f t g 1939 Ap 1 307  
 h y d m 1939 Ap 1 295  
 p b l b l h p b l m 1939  
 April 273  
 m p l c a p l m r v b e  
 l 1939 Ap 1 333  
 d f f i a l d i a g 1939 Ap 1  
 279  
 d e t l x a m f s e m  
 f 1939  
 Ap 1 317  
 p e a l p 1939  
 Ap 1 287  
 g f 1940 O c 1264  
 1265  
 l m p l c a g 1939 Ap 1  
 397 407  
 h g h e n t t m f 1939  
 April 415  
 b l d 1939 Ap 1 343
- A p p e d t h f l m p e r f t  
 g p a  
 1940 Oct 1268  
 h l c a l e d p e t 1940  
 Oct 1508  
 p e l l c e s s e t l l g  
 1939 Ap 1 423  
 p e r t m p l c a t g 1939  
 Ap 1 393  
 l e o h l r a l y  
 1939 April 401  
 p o t p e t 1939 Ap 1  
 389  
 p e r p e t c a 1939 Ap 1  
 3 1  
 r e f l g t u e d b e e  
 1939 Ap 1 32  
 m p o s m 1939 April 269  
 t h m b o p h l b m p l c a t  
 1939 Ap 1 443  
 t h b e c f r m 1940  
 Oct 126  
 d p 1940 Oct 12 4  
 h h l d 1939 Ap 1  
 344 347  
 e e d 1940 F b 5 103  
 m l r y f e s 1941 D c 160  
 A p p e d t j 1941 F b 263  
 A m p e t f t l  
 p a r a l y 1939 F b 1 1  
 p l t h g d l l 1941 Dec  
 1691  
 A m d l r e r v 1941 Dec  
 1803  
 o s d t h t g r v  
 1941 D 1569  
 M e d c a l D p a r t m t g  
 1941 Dec 1688  
 p h t h l m e r v 1941 Dec  
 15 9  
 e t h p e d c s 1941 Dec 168  
 p l t d l l f c a l e s  
 1941 D 1583  
 r e c a l m g f b d m  
 1941 D c 160  
 1941 D c 1783  
 A r t h b l m f r v 1941  
 A g 1207  
 A r s e c a l k r a t e 1940 F b 119  
 125  
 A r t l o s d b g r y d  
 1940 A g 11 9  
 t r n b l e e d e 1939 F b 153  
 A r t e n r m m t  
 1939 A g 931  
 A r t h d f m t l e e 1941  
 Ap 1 593  
 f l a t f o o t 1939 F b 32  
 A h t f m b s a f 1940 O t  
 1436  
 f h p 1941 J 895

Arth t [knee 1941 J 898	A t m oc f p g y 1940
Arth od l mbosa l ll bb	I b 49
1939 F b 39	A l f k p pl f t t
f kl j t 1939 J 715	m t 1941 Ap l 555
postop m lt 1939 F b 125	A ll y m t t ca m f
Arth pl ty t ll m cap 1941	b t 1941 A g 1066 1069
J 895	A d y t pt 1940
Arth t my k ee t f m l f	Ap l 420
sem l cart l g 1939 J 69	A ochl m d f g t f d
Art f l p t b 1939	1939 D 1363
Ap l 551 552	
A h ff theory f th mb	
1941 April 385	B p t feet f kud y
Ascorb d s Ce l m d	1941 D 1640
A ph sa b 1939 Ap l 547	B k j f t d d t y
t m t 1941 Ap l 373	1941 Ap l 524
Ap t b p y ca m f	f f f d f t l d g
l g 1941 O t 1407	1940 O t 1413
f t m t m t d t h	B k h t r v t b l d k l
1939 Ap l 519	d 1939 F b 43
Ap t f t p t p t	l 1939 F b 35 A g 943
1940 A g 99	f h t f t r v t b l
f l g b h sc p p	d ks 1941 J 889
t f t l t 1941 J 80	B t ph g y t sept
p l t ppe d t	1940 Ap l 475 501
1939 Ap l 287	g l f t 1939 D
A th l t y d f t	1384
t d f m h p thy d m	B d k hyp thy d m m g
1941 O t 1227	m t 1941 O t 1303
y h g 1941 O t 130	B d s f d m t l d
A thm bd m l p t p	1941 D 1762
f 1940 A 98	pl t m k g 1941 F b 200
y g h l m th py 1940	T 1941 D 1763
A g 1141	g l 1941 D 175 176
A t g l ct my W htm 1939	1940
F b 134	B b t t p p t
A t l f t 1940 D 186	J 62
A t c m 1940 J 655 1941	B h l t l 1939 A g
A 994	108 1941 F b 91
At l et p t p t 1941 J	gl d t b l f 1940 Ap l
816	459
b hos p p t 1939	B l m t h l t h p h
J 82	d m 1941 O 1241
y g h p 1940 A g 1134	B sel ll h g 1939 F b 244
At h l t J t tm 1940	B p t f g l h
O t 1439	1940 F b 144 1941 J 885
At phy f l d g d	B th t f t d d
1940 F b 109	1939 D 1347
A l f l 1941 Ap l	thl J 1940 O t
367	1441
A l f b ll t ft thy d	B f b p g f t f k f
t my q d m t	f m 1939 A g 937
1941 O t 1369	B l h g ppe d t 1939 Ap l
h p thy d m d g t l	330
1941 O t 1366	B ll p l 1940 J 686
A t th f thy d	B tt f t 1940 Dec 1704
g y 1941 O t 166	B ca b t f blood
A t m d 1941 D 1793	pl m 1939 D 1589
P hl m f y g l k 1940	B p m l t pl t 1939
A g 1113	Ap l 49
	B l d t cal l 1939 A g 848
	ca m 1939 A g 873 888

- Bl d t g t l bl t t  
 1939 A g 86  
 d se sec 1939 A g 845  
 d ff t l d g o 1940  
 O t 1295  
 d g 1939 A g 859 1940  
 A g 1016 Dec 1839  
 t h pat ca m 1 1941  
 A g 1117 1119  
 pl t pe 1939 A g  
 868  
 t t 1939 A g 86  
 t m 1939 A g 873  
 Bl t 1939 A g 852 880  
 905  
 l y k es 1939 A g 89  
 f t l m pl t m l 1940  
 A g 100  
 t pl t t t d od m  
 1939 A g 870  
 t t d se l g 1939  
 A g 899  
 d t 1940 A g 11  
 h m r h g p t  
 t m k 1939 A 891  
 p d po t pe t ca  
 1940 A g 1005 D 1839  
 oe g d g 1939 A g  
 913  
 ged 1940 F b 47  
 p se ce f b t r u c t j  
 d 1939 O t 1263  
 Bl th l e t f pep l  
 1941 J 681  
 Bl th l l p t l l f m t  
 mod f i c a t 1939 J 609  
 B p o j p ca m f  
 l g 1941 O t 1407  
 f t m m d h  
 1939 Ap l 519  
 d t u l 1940 Ap l 451 1941  
 J 924  
 b m 1941 F b 78  
 m l g d a se l m  
 1941 O 1477  
 f b o 1941 A g 1159  
 f 1939 D 1467  
 B h m f l 1939 D e c  
 1366 1389 1941 Ap l 565  
 Bl k t l l g p s o l 1941  
 Dec 1795  
 Bladd m t 1940 F b 277  
 cal f c u t o s e p d e o 1941  
 F b 138  
 f l l g t r a h l p  
 ect m 1941 O 1375  
 ca m 1940 F b 66 Ap l  
 413  
 bl 1940 Ap l 545  
 d se ce d ff t l d g 1940  
 O t 137 1371
- Bl dd xam bd m l  
 t m 1939 Dec 149  
 ph f f t t pl  
 t t f t ectos gm d  
 f 1941 O t 1399  
 l 1941 D 1650  
 t h m 1940 Ap l 44  
 g t f t h l p  
 ect m y 1939 F b 183 184  
 1940 A g 1071  
 k c f h l d  
 1940 Ap l 389  
 b t t t d h ca  
 m f t m 1939 O t  
 119  
 og y o c p y 1941  
 F b 138  
 m e fa d y f c t h l  
 d 1940 Ap l 390  
 d t t d t 1940  
 Ap l 491 495  
 pap l l m 1940 F b 66 Ap l 412  
 t m 1940 F b 66 Ap l 412  
 p 1941 Dec 1650  
 B L B h t p p t  
 1940 A g 1150 l l 1158  
 Bl od bu k d hock  
 1941 D 1674  
 h m cal d g cal th p  
 1939 Dec 1583  
 h l l f g h p a r t h y  
 d m 1941 Oct 1248  
 m p a t b l y 1940 J 86  
 d y s e r g od od l h m  
 h g 1941 J 726  
 bl l e 1939 F b  
 154  
 g p s 1940 J 875  
 od h p e t h d m 1941  
 Oct 150  
 oc l p e p l 1941 J  
 668  
 pl m l m l h k  
 1941 D 1676  
 p e s l p l e s h u  
 1940 J 631  
 hock d 1941 Dec 1664  
 ra f See T f  
 B ca m m t t cal m  
 1940 Ap l 540  
 d l d 1941 F b 245  
 graft un ed fract f k l  
 f m 1939 O 1235  
 m l g n m 1941 A g 1153  
 B h u l pl black 1941 F b  
 28  
 j r y t p 1939 A  
 957  
 B 193 D 1401  
 1941 Ap l 311  
 ch l d 1941 Ap l 327

<p>             Bra t 1939 Dec 1401              1941 Ap 1 327              f t m b o l m 1941 Ap 1 545              J es 1939 Dec 1401 1941              Apr 1 311              m h l d 1941 Ap 1 327              lacer t 1941 Ap 1 311              h l d 1941 Ap 1 327              m g m 1939 J 727              p e n t t k d 1941              Dec 1631              t m d i a g n 1941 A h 981              m p o r t f p t r v              t p h 1941 J 903              p e b l t y d l t f p e              t 1940 J 653              o e t g t h p y 1940 J 870              r g c a l t t m t 1944 A e              9 9              m p t m 1941 A h 983              J t m f 1941 A g              995              B h l p l t 1940 D 1809              B e a t c a m 1941 A g 1063              b l 1940 Ap 1 546              d e a l m t e c t m y f 1939              J 755              o e t g t h p y 1940 J              872              t h l t f d e a l m t              t m y 1941 A g 1063 1068              m t h f l g r y f 1941 F b 6              B t h f l p p e d t 1939              Ap 1 330              B e e c h p t t 1939 F b 249              B t p t f d p f t              1939 F t 134              B d m t h o d f g d g c a              1941 A g 951              B h t 1941 D 1601              b d l p e t p f              1940 A g 978              B l t t m y f 1939 J 745              h g m 1940 F b              163 167 1941 A h 1083              B o n h o e p p f l h              t l e c t 1941 J 821              B h p 1941 D 1600              d t d f 1939 J              817              i l g 1941 A g              1090 O t 1407 1431              h l d g g l p f              1940 A g 1133              t h d s e 1940 A g 958              c t f t b t l g t e c m              1940 J 778              g y f p p t l 1941              J 686              P k t 1940 D 1743              1941 F l 220           </p>	<p>             B l l e c t 1939 J              685              m o d f i c a t f l l y t b l 1939              J 60              p e n t 1939 J 681              t e c h f f h l j e c t f              p t 1939 J 691 69              B p f t 1940 D 1782              B p 1941 l l 169              B t t m y b l k t h 1941              l b 293              B h p e t 1939 F b 119              B f l l f d s g y              N D p a t m t g t              l l t 1941 D 1534              B 1939 D 1489 1941 D              1734              o d l l 1939 D 1504              f d d t y 1941 Ap 1              527              R t l t 1939 D 1504              f t d 1939 D 1507 1941              D 1749              m l t p t 1941 D 1529              1734              f y 1939 D 1496 1497              f l d 1940 Ap 1 577              h k 1939 D 1501 1941              D 1735 1736              t d 1939 D 1502              t m 1939 D 1505 1941              1735 1736              B l t t t m 1940              F b 13              B t p l t 1941 Ap 1 510              b m l p t m t 1940              J 849              C d e g t h p              1940 A g 1139              C l e a p l y t 1939 F l 134              C l m m t f l              1940 Ap 1 540              C l l b l 1939 A g 848 905              909              f t c a m 1941              A g 1122              m m d t 1939 A g 909              l 1939 O t 1285              p t y l l              1940 Ap 1 299              t p t 1940 A g              1057              l 1939 Oct 1275 1940              Ap 1 332              o s p d p y l g p h y              1941 l b 145              m p l t 1941 F b 153              m f l g 1941 F b              155           </p>
--	--

## 1816 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

Cal 1	cal ex to e p d g o s	Ca	m f r v t n d t
1941 F b 135		th p 1939 J 811	
f l l g tra thral p ost t		815 1940 Jun 871 1941	
ec m 1941 Oct 1375		A g 1195	
C ld l l b g g ca t 1940 D		g cal m thod pl rr d	
1640		t 1941 A g 1195	
Cal f m l t t l t l		f h k 1941 A g 973 1018	
f l g 1940 J 853		l col 1939 F b 209 O t 1119	
Cal s d 1940 Ap l 300		1123 1940 Oct 1322 1334	
Campbell pe t f d p foot		1941 A g 1129	
1939 F b 134		m 1939 Oct 1159	
f pa l y h p g 1939		dec mp p oced 1941	
F b 99		A g 1145	
Ca St C		g d 1940 F b 5 34	
Ca th ca m f 1941		loop col t my f 1939 J	
A g 971		649	
Cap t l l m fra t 1940 D		M kul ese t 1939 J	
1656		637	
Cap l h phy f h b l d loca		b t 1941 D 1613	
t f h ld 1939 F b 63		pe bl 1941 A g 1143	
Cap l t my po t 1941 Ap l		t g mb d l d m o	
600		pe f se t f 1939	
Ca b l 1939 D 1383		A g 1011 Oc 1132 1941	
f k d y 1941 D c 1643 1644		A 1134	
f k 1941 F b 38		p e d po pe ca 1940	
oe tg th p 1940 J 8 2		A g 1033	
1941 F b 237		oe gen l e 1939 Oct	
Ca m b p l m t		1083 1940 O t 1560	
1941 O t 1477		f cr l l e 1940 J 68	
b on h g 1941 A g 1083		f ph g bl 1940 Ap l	
rt r m d 1940 F b		542	
163 167		l se t f 1941 J	
g d g f m se p 1941 A g		649	
947 Oc 1476		g cal d th my 1939 A g	
g d 1940 F b 117		1003	
bl 1940 Ap l 531		f f 1941 A g 969	
t l bl 1940 Ap l		f f m l p l bl 1940	
541		Ap l 545	
m l g f 1941 A g 947		f f h d 1941 F b 41 A g	
Oc 14 6		973	
f d l rt 1941 A 1165		f g l l b l d d 1939 A g 888 906	
f 1941 A 1129		1941 A g 1117	
f b l d t 1939 A 873 888		f h p d 1939 O 1125	
1941 A 1117 1119		l k d y 1941 A g 1173	
f b l d d 1940 F b 66 Ap l 413		f l ry 1941 A 1030	
bl 1940 Ap l 545		cabl 1940 Ap l 54	
f b m t l m		f l p 1939 Dec 15 1940 F b	
1940 Ap l 540		124 1941 A g 9 6	
f b t 1941 A g 1063		f l ged 1940 F b 48	
bl 1940 Ap l 546		l l g bl 1940 Ap l	
rad cal m t my l 1939		543	
J 755		p mary 1940 F b 163 1941	
es l f rad cal m ec m		A g 1083 Oct 1405 1431	
1941 A g 1063 1068		b h se p 1941 Oct	
oe tg th p 1940 J		1434	
872		f m y d od l pap l l 1941	
f m 1939 O t 1123 1941		A g 1117 1119	
J 837		f m h 1941 A g 1017	
f r t 1939 J 811		f sal p sag 1941 A g 1009	
1940 Oct 1385 1941 A g		f soph y 1940 F b 154	
1189		1941 A g 1011 10 7	





## 1818 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

C l g g l t f e t l	Ch k m 1941 A g 971
hype t 1939 O t 1205	1018
C l l t oe g t tm t 1941	Ch l r r h phy 1940 Ap l 59
F b 238	Ch m cal t m f m 1941
pp t f p h l g f f i g	Ap l 333
1940 O t 1464	Ch m h p g cal l t
C m t k d 1940 Ap l 395	1939 D 1386
C l l t m 1941 A g 100	f l 1941 D 1733
C bell po t g l t m f	1740 1745 1746 1748
1941 A g 100	Ch t d s e s f m l y f e
C b l og phy h d j es	1941 D 1599
1941 Ap l 314 320	j t m 1941 Apr l 371
m t m g m f	m g t tm t 1940
m l 1939 J 727	O t 1473
C r v call mph d t 1941 F b 31	g y f h f th t
C r b m j vag j b j	1940 A g p 5
g g g 1941 J	m l c a y p e t 1941 D e 1593
867	p d p o t perat 1940
b p y 1939 D e 1467	A g 953
m See C f	t 1940 Oct 1477
t t 1939 D 1468	pp g 1940 O t 1474 1475
t l y 1939 Ap l 544	j 1941 D 1594
h l b r th j 1940 J	d p e 1941 Ap l 377
825	Ch l d b r th l 1940 J 825
h n j l	Ch l l g y f 1940 O l 01
1939 D 1465	Ch l d t f b l o d p l +
t 1939 D 1470	m 1939 D 1589
j t t j y 1939	Ch l g g ph 1939 A g 859
Ap l 543	880 1940 A g 1022
l t p p a 1939	Ch l g 1939 A g 845 847 907
Dec 1472	p e p e t 1940 A g 10 9
l k p l k 1939 D e 1476	l f l l 1939 O t 1269
l g t l s o e t g th	Ch l t 1939 J 597
p 1940 J 871	l 40 Ap l 514 1941 Dec 1608
h r v 1941 F b 81	t d c a 1940 J 90
p p l l m 1939 D 1476	d f l l g 1940 A g 1225
p l p 1939 F l 158 Dec 1475	d f l l g 1940 O
p e e e l e v 1939 Dec	1247
1465	Ch l e c y t m 1939 A g
C s a t 1940 Oct 1517	875
h h p t 1939	Ch l e c t 1939 F l 215
F b 261	A b 886 90 1940 Ap l
t m l d f t l m t l	511 J 750 793
1940 Oct 15 7 1530	m l t f 1941 D
t l z a t h 1940 O 1531	1608
C t m d f t d h l	h 1940 Apr l 518
g 1940 F b 229 231	d f f l d g 1940 O
p g 1940 F b 254	1298
m l blood l l 1940 F l	b t 1940 J 793
227	Ch l o g m p 1939
p p e t l m t	A g 918
t m C l f i 1940	Ch l y g ph l 3 A g 914
F b 228	Ch l o m 1940 Ap l 514
Ch l 1941 F b l	1941 D e 1610
Ch l f f p e 1941 D 1650	h l e c e t m 1940 J
Ch d l t d t p l	793
1939 F b 95	Ch l d o c h r r h l 1939 A g
Ch t m j p f	846
1939 A g 853	Ch l d o c h l d m 1939 A g
Ch l y h r e 1940 O 1443	869
	Ch l d o c h g ph 1940 D 1844

Ch l docho graphy mmed t 1939  
 A g 859  
 p t p e t 1939 A g 880  
 Ch l d h lth 1939 A g 848  
 855 909  
 Ch l d h lth t y 1939 A g 855  
 Ch l d h lth t m 1939 J 597  
 Ch l lth 1939 A g 905  
 t d g 1940 O t 1298  
 h p e th y d m m k l b y 1941  
 O t 1238  
 Ch l t t m f b 1941 A  
 998  
 f ual l t 1940 J 678  
 Ch l i l blood f t g h y p  
 h y d m 1941 O t 1248  
 Ch d m f l y 1940 J 717  
 Ch d m m l g i 1940 t t 155  
 Ch g d l p f t l  
 t bleed g 1941 O t 1448  
 Ch d l t h m t 1941 Ap l 339  
 Ch m f b d 1939 A g 107  
 Ch m e y e p i j y  
 1941 Ap l 449  
 Ch l th 1941 Ap l 379  
 C l t l d g e 1940  
 A g 1110  
 Cl m t F h l h p t 1939  
 f b 83  
 Cl l f t 1940 D 1613  
 h l d 1940 Ap l 549  
 Cl f t h l t d p l t  
 l f 1939 l b 82  
 Cl f t p a l 1940 Ap l 593 598 600  
 Cl k d p l t t t f  
 p o d f t e 1941 D  
 1530 1698  
 f m y l 1941 D  
 1700  
 f d 1941 D  
 1530 1728 1743  
 Cl b f o t t d p l f  
 1939 f b 83  
 C g l t b 1939 D 1546  
 1549  
 C l m l l  
 1940 Ap l 540  
 C x h l f t d h l  
 J 1941 Ap l 357  
 C J l l b I 39 D 1504  
 C l d t t h p I 39 A  
 971  
 C l p p e i t i o A l 281  
 l l 1939 A g 852 880 905  
 C l l 1939 f b 1  
 211 O 1093 1101 1177  
 1179 I 41 O 1350  
 I 39  
 O 1157  
 t f p e 1939  
 J 629

C l t l t l o t g  
 l g 1939 O t 1078  
 l f l l 1939 O t  
 1039 1092 1096  
 C l l p t h p p l y t l  
 l 1940 A g 99 O l 1485  
 C l l t t b 1940 O t 1466  
 C l f t 1939 D 1447  
 1940 D 1683  
 t t l l d l p t l  
 1940 J 843  
 l 1940 D 1693  
 C l l k t k 1941 O t 1333  
 C l b o m f l d 1940 Ap l 585  
 C l d m t 1939 O t 1135  
 m b o e t g d g 1940  
 O t 1549  
 m l o t g d g 1939  
 O t 1071  
 m S c l f l  
 l g m f 1940 A g  
 1041  
 d l t t l l path  
 1939 O 1163  
 d 1940 O 1317  
 m l t 1939 O  
 1157  
 d t p l p p t  
 1940 A g 1226  
 d f f t l d i a g o s 1939 f b  
 203  
 h l g 1939 O  
 1071 1086 1940 O t 1535  
 y m p o m 1939 O t 1071  
 l t l 1939 O t 1105  
 e t g d g 1939 O t  
 1074 1940 O t 1554  
 d l 1940 O l 1348  
 e g l g 1940 O t  
 1552  
 f l d d 1939 O  
 1073  
 r r l l 1939 O t 1141  
 m l g d p d post  
 p e e 1940 A g 1033  
 p e d s a l b l  
 d 1940 A g 1199  
 p h l g m d p e f d d  
 t l m 1939 f b 210  
 p o l 1939 F l 207 O 1080  
 1135 1940 Oct 1344 1941  
 J 845  
 e t g t l d b l  
 850  
 b b o e t g d g  
 1939 O t 1077  
 p h l o e g d i a g 1940  
 O 1550  
 t l l t g d g  
 1939 O 1082

## 1820 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

Col	t m	oe tg	diagnos	C	t t b th f	thl	j es
1940	Oct	1554		1940	O t	1441	
f f	oe tg	d g os	1940	f	co t sed	d	1939 Dec
Oct	1540			1347			
C l	pe	d t	g	C	sed	d	1939 D 1346
t l d locat	f h p	1939	F b 10	C	t f h	1939 D	1401
C l t y	1941	F l	259	1941	Ap l	327	
bag	d belt	1941	F b 274 275	f k	d bc ta eo t		
f	dec mp es	f col	ca	huld	1941	Apr l	537
ci m	1941	A g	1147	f pnal	d	1939 Dec	1416
loop tech	1939	J	649	1941	Ap l	434	
m	g m	1939	Oct 1133	C	l	post p ra	1939
1940	F b	28 A g	1230	A g	960		
g d	1940	F b	30	C	l l d re	g lth ps	
mea	f d g	1940	Dec. 1869	1939	Ap l	533	
pe m	t ma g m t	1941		C	mea blood t	1941	Ap l 336
F b	273			bur	1939	Dec 1496	
C l poel	t t l	d cat	f	h m cal	d rr d t	tra m	
1940	J	826		1941	Ap l	333	
C l porrh phy	d t	f	1940	dy t ph	thy d d se	1941	
J	825			O t	1315		
C m d	pe	f	1939 A g 1032	os	t	1941	Ap l 333
C mm	d ct cal l	1939	A g	for g body	m l	1941	F b 8
848	8 5	909		l	1941	F b	11
d	t h lec t t			d	pe f	g	1941
1940	J	793		34			Apr l
d l	1940	A g	10 4	pe f	l	1941	Ap l 331
d	g	1939	A g 859	C	ry rt y l	g t	t
t t	1939	A g	862 907	C	t l	d	1941 J 773
g ry	T t le	1939	A g	C	d p oc	f t	1940
860	1940	A g	1016 D-c	D	1657		
1839				C	l cart lag	lect	1941
t m	1939	A g	874 910	373			Apr l
C mm t th ra	1940	Oct	148	j	1940	Dec	1631
C mp	d ll	g th		C	pe t g	h l	1939 F b
py	1940	A g	1139	193			
C mp	y os	1941	Ap l 373	C	ul	t tm	
f p	l cord	1941	Ap l 434	1941	Dec	1623	
t ma	f che t	1941	Ap l 373		pa ly	pos pe t	
C	J	f bes	1941	1939	A g	9 8	
D-c	1528			l	d se	flec g	1940
f	ym pa m	d l b	h	J	675		
f b	1941	Dec	1576	C	ph ry g m	1940	F b 155
Ap l	311			C	t m	b t m	1941
hld	1941	Ap l	3 7	A g	985		
f p	l co d	1939	D-c 1416	C	h d	1941	Oct 1250
C dyla	f f f m	1940		C	os y	ffi m h	
D	1765			od	1941	F l	7
f h m	1940	D	1655	C	se	l t od f	t
C ly f m	f l	1941	F b 89	1939	D	14 0	
C	t f ry	1939	D 1470	C	ll g m	j	1940 U
C i ct	l b l b	f m g pe		1453			
t	1940	F b	2 223	C	bo d bo	f ct e	1 40 l ec
b	1939	D	1496	1831			
g y	1941	F l	l	C	f m bo	f	1 40
C t t	D p yt	1939	F l	D	1831		
238				C	b l t	f l g	t f
f	h d	1939	F b 34	C	fl	g	1941 O t 1473
f m b m	1939	Dec	1 08	C	t g	f g	fl m f
l km	1940	D-c	1664	d	1939	O	1311

C r t h g h f e q c y k	D f i p o t p e r t 1939 A g
1939 D 1545	96
C t m t f t 1941 F b 81	D f t f l p t m 1941
C l g l 1941 Ju 723	F b 26
C h g d m 1941 Aug 1167	D h l t h l d 1940 O t
1168	1512
C t a h 1940 F b 122	h d l 1939 D 1413
C t t g e t 1939 D 1547	p d p t p a 1940
C m p e s 1941 Ap l	A b 1197
373	g m M d m
C y l p p a t h 1939 A g	1940 J 723
1054	D l l f b o 1941 F b 245
p l m y m l c a t 1940	D l t d p a l p o t p l m l t
J 63	1939 l b l l
C y t B r h l 1941 I b 91	D t f k d y 1940 Ap l
h t 1941 F b 71	296
d r m d l 1939 A g 10 9	D l C p A y 1941 D 1533
l a r y g l 1940 I 70	1541
m l t l e l 1939 A g 10 8	h l y 1941 D 1803
p l d l 1939 A g 1026	D m t f l d 1940 Ap l 576
C y t a d o c a m f 1941	D m t l g b 1939 Ap l
A g 1207	459
C y t e c t m y i t t l f b l d d t	D m d l 1939 A g 1029
m 1940 F b 69	D d f l l t 1940
d c a t d m t h d f d l	J 678
g t h t 1941 I 875	D 1549
C y t d t t m 1939 A g 874	D t t J f l m p m d
C t p o t p e t 1940 Ap l	l b t h 1941 D 1576
491	D b l l t h t g t
t b e l p t p h t m 1940	1940 A b 927
A p d 401	h p t h d t h g d
C y t p y 1941 F l 135	1940 F b 40 42
C y t o s t m p p b 1941 D	g y 1940 A g 1179
1657	D b t g g l t f f o o t
C y t m b l k t h f 1941	t u m t 1941 Ap l 515
F b 290	D g m m p l l m m
C t t h p e C a m p l l l 1940	D p m 1939 O t 1247
A p l 378	D p h l m l l t 1941
	O t 1383
D e o c n p l t 1940	t f 1941 O 1386
A p l 583	1396
D k f d 1939 D	m f 1941 Ap l 379
1363	D p h m h 1941 J
D d p t f M	657 O t 1385 1394
d m 1940 J 722	h d m l h p
D k l p t t d 1941	p o a h 1941 J 660
D 1795	p h r v t p
D t m t f h l l l l c	1940 A g 961
t f h l l 1939 F b 61 6	m 1940 O 1480
D b l m f k d 1941 D	D r r h t p p e l 1940
1645	O 1269
f d 1939 D 1360 1941	D h m m d c a l h l t J
D 1731	1940 O 1440
D m p c a m f l	g l m l s p h g
1941 A g 1145	1939 A g 1003
t l l t 1939	f d t l m d 1940
F b 161 1941 D 1616	O 1352
t m f b 1941 A g 1004	D h l 1941 J 665 666
p t f f l p l y 1940	D l p e f p a l
J 687	h p g 1939 F b 99

# 1822 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

D t i c t e a f j l 1941	D r t l n o p h g l 1941 J
D 1526	631
h g c a b o h d t 1940 A g 12 2	t o t g p t 1941 J
h p e r t h d m 1941 Oct	63
1263	g t h m r h g 1941 J
h l c a 1940 A p l 537	7 5
p e p t l e e 1940 A g 1212	D r t l f l 1939 F b
p e g n d l a t 1940	210 O 110 1940 Oct 1554
F b 259	D l f l 1939 Oct
r y l c t 1940 A p l	1074 110 1940 O t 1348 1552
423	D r t l m s o p h g l 1939 J
l d 1940 A g 1229	583 591 1940 F b 185
p o s t p e 1940 A g 1211	W e e k l 1940 Oct 1501
g r e 1941 J 785	D r a g f t p p e d e t m 1939
p e o p e t 1940 A g 1211	A p r i l 367 38 395
r e s d f e e 1940 A g 12 6	m p m 1939 J 7 1
D g t l v a m t c a m f	f m d t 1939 A g 8 9
e o l d e c t m 1941 A	1940 A g 1016 D 1839
1130	f t m t d 1939 D e
f m l l 1939 A p l	13 0
317	D g f m t d 1939
D g t l h y p e r t h y d m 1941	D e c 1367
O c t 1262 136	h t g c a l f c t 1939
D u l t l l e e r v o t 1941 F b	D 1585
81	m p s e d 1941 D e c 1751
t l t y 1939 A p l 543	D k p p r a 1939 A p l 5 1
f l g l d p t h	D p f o o 1939 F b 134
1939 O t 1163	D o d m d e s e d p d
f s o p h g u f c a d p a m 1941	p o s p e r a 1940 A g 1211
J 644	f l 1940 A g 1003
f t m h d h 1939	h m r h g 1941 J 721 729
F b 169	p a p l l m j c a m l 1937
l t g l 1940 A p l	A g 1117 1119
327	l 1941 J 665
f t h r a 1941 D 1657	D p t 1939 F b
h p r o t 1940 A p l	238
371	D u r l d t h l m b n l
D m p l l 1939 A g 103	m 1940 J 681
D t s e p e 1939 J 818	D m m f 1941 A g
D s e o g y j m 1939 F b	1207
53	D k t l r l 39 A g 879
D l o c a t e r m o c l l 1940	D m h j m 1940
D e c 1618	J 805
t r a h t a 1 41	p s e p s e r l e e
D 1556	f 1941 J 855
l o c l t h 1 41 D e c 1554	D l 1940 A p l 300
f l b o 1940 O 1447 D	
1660 1662	
f f i g r s 1940 D 1718	
( h p 1940 D e c 17 4	
c o g t l 1939 F t 3	
l p l l a r r 1939 F b 95	
f h l d 1940 D 16 0	
b t p e a r t h t f l l e	
1940 J 849	
h a b u a l 1939 F b 59 1940	
D e c 1625	
f 1940 D 1700	
t o c l l 1940 D e c 1618	
b a t e l d 1941 A p l 50	
D p e s a N l 1941 D e c 1541	
	E d j 1941 A p l 36
	1941 D e c 1574
	d f d 1941 D 1580
	l t d l h d j
	1 41 A p l 357
	l d j 1941
	D e c 1578
	p f l o d l 1940 F b 128
	m l r s 1941 D
	1569
	E d m t 1941 F b
	13
	p 1941 F l 14

Ea drum pt f by bomb bl t	E d th l l l m 1941 \ g
1941 D 1576	1156
Ecthma α tg t tm t 1941	E l th l d ff f l 1941
F b 239	\ k 1156
Ect p cat l 1940 Ap l	d l bo l m t 1940
583 584	J 681
Ed m l d < < 1940 \ g	F m h t t t t l
119	g 1940 A k 1095
p lm r g by po t	F g l M y d ect l g fi d
p es 1940 A 1126	1940 D 1732
p t p t 1941 J 8 6	Γ t t h 1940 J 740
Ej l t d f 1940 Ap l 483	t b l 1939 O t 1172 1173
Elbo d locat 1940 O t 1447	1183
D 1660 1662	g i g 1941 J
f t 1940 D < 1645	829
mpo d 1940 Dec 1662	t t t y f p l t l 1939
t t 1941 F b 224	F b 161 Ap l 415
pc f t l p h	Lphed p l th 1939
1939 F b 125	A g 1055 1941 D 1548
t 1940 O t 1045	Γ p d l f t 1940 D
Elect ocoag l ca m f	16 5
ct m ged 1940 F l 32	Ep l d t m 1941 D 166
f rv 1941 F b 89	f t b l 1940 Ap l 405
El t e ph low phy 1941 A k	Ep d l m t 1941 F b 119
982	k h l 1939 F b 194 1941
Elect g h g f q	k D 1661
t 1939 D 1545	t b l 1940 Ap l 404 1941
F b l t m 1941 Ap l 395	D 1661
Emt l m f t g d 1940 F l	Ep ph l p t f m l l
8	1940 D < 1763
t m t 1941 Ap l 543	Ep t 1941 F l 22
p lm y f l g t m d	Ep th l m h h f q y t
g y t l t m t y d	1939 D 1534
p l 1941 Ap l 383 390	g l 1940 t b 125 127 132
394 396	f h k 1941 \ g 1018
pot pe 1941 J 8 3	f y w 1941 A g 10 0
h k y g h p 1940	f p 1940 Ap l 416
A g 1134	f ph 1941 A g 1029 1030
Em g g cal f b l m	f l p l 1941 A g 1176
m l t y f 1941 D 160	f h y d g t l 1941 A g 1048
Em t d bl l 1939	f t g 1941 A g 10 3
O t 1142	g m 1941 F l 241
Fmphy m ld m l p t	q m ll f f 1941 A g
p e f 1940 A g 981	974
l t h J	Epo h 1940 O t 1458
1940 O t 14 9	F l l b m d l b l l
Lmp 1939 J 751 1941	l 1941 Ap l 359
D 1598 1600	Eq l m p d 1941 D
h j 1940 O t 1481	1751 1764
F ph l s ph 1939 J 730	Γ t l k al t g f thy
F loc t bl l 1939 F b	1940 Ap l 567
159	E f 1941 J 867
Γ loc bl d g 1941	Γ pel 1941 l b 59
J 870	g t m 1941 F l 238
F d m t l b p 1 40 Ap l 451	Fsoph g ca f rabl
1941 J 924	1940 Ap l 54
F l m 1 40 J 799	rg l l th m y 1939
l d m t l t 1940 Ap l	\ g 1003
451	d l t f ca d pa m 1941
F l t f l d p h 1940	J 644
J 681	

- Esoph g d rt l 1939 J  
583 591 1940 F b 185 1941 J  
631  
t o-t g pe t 1941 J  
635  
hiat h ua 1941 O t 1383  
1387 1389  
l er d esect f ca ca  
1941 J 649  
papt l h m rrh g 1941 J  
727  
J es h m rrh g f m 1941 J  
726  
Est og f t l l 1941 Oct 1451  
g 1941 Oct 1451  
Eth h p l m y m l  
t 1940 J 624  
Fihyl he-u p l m ry med  
cat 1940 J 624  
E th bl ca 1940  
Apr l 532  
E uat h p t l rth ped es  
1941 Dec 1695  
f d l pl f 1941  
Dec. 1692  
E t l f diaphragm 1941 Oc  
1386 1396  
E g 1941 A g 1156  
E f d 1941 Dec 17 4  
1741  
E l p t g t l l l  
l f l l g 1941 J  
748  
E se hlt y es 1940  
Oct 1441  
sed d 1939 Dec  
1347  
m bluz g sc l 1939 F l  
140  
E phth lm g See Hyperth  
oid m  
E phth lm 1941 O t 1313  
bl t l hlt 1941 O  
1318  
m lgn t 1941 O 1315  
po t p 1941 O 1314  
q l 1941 Oc 1325  
E oses d rsal d m J l h  
h ll lg 1939 J 721  
E t phy f bl dd f  
t pla t t l rs  
ctos gm d f 1941 Oc 1309  
F t p l J m l t g  
ra bd m lt m 1941 Ap l  
417  
E trem mp x 4 p  
l t  
f ct g l p 1939  
Dec. 1437  
l er pe t f t l  
pa ly 1939 F b 131
- E t m t l t d t pl  
t t 1939 F b 79 Ap l  
493  
tra m d rg ry  
th mbos d p lm ry m  
h l m ft 1941 Ap l 383  
396  
pe t h f th t  
1939 A g 97  
d t tm mm bluzat  
1941 Ap l 571  
E l tl J 1941 Dec 1563  
b 1939 D 1496 1497  
bo t 1941 A g 971  
h g d e ses f thy l  
gl d 1941 O t 1313  
hypert 1941 O t  
13 2  
h p m t bol m 1941 Oct  
13 l  
oc l t ry th ua  
1941 Oct 1320  
d f t A my p pect d  
ll t 1941 D  
1361  
f gn bod pe g 1941  
Ap l 340 Dec 1787  
g J 1941 D 1564  
J 1941 Ap l 331  
d d e ase A m serv  
1941 D 1563  
first d d try 1941 Ap l  
5 3  
gl m f ll g 1940 F b  
215  
med lg lp ll m 1941 Ap l  
349  
pe t g 1941 April 331  
pe g 1941 Ap l 339  
m rg ry 1941 F b l  
g ry A m g 1941 D e 1559  
m g 1941 Ap l 348  
E l h d 1940 Ap l  
5 6  
E l d b 1939 Dec 1496  
1940 Ap l 577  
m 1941 A g 971  
d m 1940 April 576  
d thy d d e 1941  
O t 315  
p h l m hgh feq cy  
1939 D 15 4  
J 1940 Ap l 573  
t f 1940 Ap l  
586  
g ry f 1941 F b l  
f ca m 1941 A g 969  
pe h ce f h  
1940 A g 924  
pl g ry 1941 F b 37

F p eca l 1941	F g t p d pped 1939 F b 244
A g 970	F g d loc t 1940 D 1718
d t eatm t 1941	f t 1940 D 1711
D 1583	J f i t d d t y 1941
F l p ly 1940 J 685	Ap l 524
F sc Ge t t 1940 Ap l 309	thl t 1940 O t 1454
lat t t f sc t ead t	pp t ll t 1940 O t 1464
1939 Ap l 487	bbbed 1939 F b 731
l g f i t f t 1940	F t p t g t j j l
Ap l 465	lee f ll g 1941 J 748
F sc l l g l 1939 F l	F t l d g h k d 1941
146	D 1665
p f h l f t f 1940	b d p l d j
O t 1468	1939 D 1401
f k 1940 Ap l 560	b 1939 D c 1493
F t mbol m ged 1940 F b 8	d t l d t 1941
t m t 1941 Ap l 543	Ap l 519
t m t f b t 1941	m pns m 1939 Dec 1345
F b 77	F l f t l th 1939 A g
F l mpa t 1940 O t 13 3	1024
F d g p t p t g t	F t l t l p t pe t
g y 1941 J 785	p k g f 1940 A g 1085
F t See F l	b l ry mpt t t l 1940
F l 1940 O t 1401	A g 1020
F m t f d l g 1941	t pl t t t d d m
A g 1167	1939 A g 870
F m f t 1939 D 1453	d od l 1940 A g 1003
dyl 1940 D c 1768	g t j j oc l 1940 J 767
t lyl 1940 D 1763	773
t t h t 1940 D	p th t t m 1940 Ap l 443
1738	445
k 1940 D 1725	t g l 1939 A g 1024
pe t f t 1939 A g	t g l 1940 Ap l 336
927 1940 F b 75 81	rv f ll g t th l
h ft 1940 D 1743	p t t my 1941 Oct 1372
t d b g ft d sm th	t l 1939 O t 1303
P se f 1939 O t	g l 1940 Ap l 443
1135	J 813
h d l d l ca 1940	F t pe t f t f
D 1724	f m l k 1939 A g 927 1940
r phy p 1940 D	F b 25 D 1731
1769	Fl l lb 1939 F b 126
F b ad m f t 1941 F b	foot 1939 F b 133
67	t 1939 F b 126
Fl l f ll d g f	Fl fort kcal t tm t 1939
1939 F b 155	F b 21
Fl m pl ry g l 1940 F b	Fl t t f h d 1939
155	F b 234
f t m h pa l 1941 J	d f mt f knee 1939 F b 95
715	1941 Ap l 593
Fl y m f g l l l ed	Fl pl y lb w St dl 1939
1941 J 808	F b 125
l t f bo 1941 A g	th mb 1939 F b 127
1156	Fl ht geo f t d tra
f soph y 1940 F b 155	g 1941 Dec 1708 1799
l l 1939 F b 159	Fl d dm t t 1940 J 883
l l l f 1939 Dec 1454	892
1940 D 1787 1795	b l ry ra t rgery 1940
h hl l 1940 l 1782	A g 1008
l l l l l 1941 F l 28t	ga rg ry 1940 A g 995
l l l l l 1939 F b 244	



## 1826 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

- Fl d dm t t test l b  
 ru t 1940 J 86  
 p d t m t f  
 hock 1941 Dec 1672 1769  
 l g 1940 A g  
 1191  
 th ra g r 1940 A g  
 968  
 th l post et my  
 1940 A g 1068 1072  
 Fl l l l h rt g g l  
 pat t 1941 Ap 1 584  
 g 1940 J 883 A h  
 119  
 h l l 1940 Oct 1512  
 Fl < p f localizat d  
 m l f f gn bodies 1941  
 Dec 1785  
 f d f f et es 1941  
 Dc 1788  
 l l e e 1940 D 13 l  
 f k d t parat 1939 A g  
 1041  
 Fly g persr l l m l w r ces  
 1941 Dc 1796 1797  
 F t rth od 1939 F b 120  
 l t d t pl t 1939  
 F b 8  
 d t b 1941 F l 169 Ap 1  
 495  
 d p perat f 1939 F b  
 134  
 pe parat 1939 A g 9 6  
 flat 1939 F l 21  
 f et 1940 D 181  
 j es fr d l r 1941  
 April 524  
 m l pl 1941 Ap 1 504  
 m l l t 1939 F b 24  
 m h 1941 Ap 1 495  
 m cl mb l 1939 F b 101  
 pe f l pa l  
 1939 F b 120 13  
 d pl 1939 F l  
 81 Ap 1 496  
 F m l l l 1940  
 J 677  
 F ps l ch p e 1939  
 F b 2 8  
 F m l h l f 1940  
 f 845 O 1893  
 l k 1677  
 d l e f d  
 1940 J 84  
 So t pp 1941  
 Ap 1 580  
 f et es 1939 Dec 1446  
 pe f l p l  
 1939 F b 126  
 F h d ca m 1941 F l 41  
 A g 913
- F b Lod fl < p f loc l  
 izat d m l 1941  
 Dec 1 85  
 rn 1941 F b 8  
 1941 Ap 1 523 D  
 1787  
 pe trz g 1941 Ap 1 340  
 s l l 1940 Ap 1 576  
 b d 1941 Ap 1 491  
 Fossa po t les pp ca h t  
 1941 A 908  
 F th gl perat 1940 J 8 6  
 F et d l ca m sal  
 1941 Ap 1 500  
 F et B et 1940 Dec 1 04  
 b mpe 1940 Dec 178  
 C fl es 1939 D+ 1447 1940  
 D 1683  
 m l d qrd 1940 J  
 843  
 mpla f l l g 1940 J  
 841  
 mpe d 1939 D 1443  
 l w el pl t m  
 1941 Dc 1530 1608  
 m l f e 1941  
 D 1 01 17 9  
 ma g m l l l 194  
 D 1685  
 f 1941 Dc 1687  
 l l ed 1941 F b 24  
 h d d n 1941 Ap 1 5 6  
 fl o c p d 1941 Dc  
 1783  
 mm f l l l h x k  
 1941 D 1668  
 m sed j l d  
 1941 Dec 1 63  
 h l l hood j f m f m  
 gr h rrec f 1940 Apr l  
 589  
 h w 1941  
 l k 1556  
 local h 1941 D  
 1554  
 va g m t \ 1941  
 Dec 1 03  
 l kl 1 39 D 1455 1 40  
 D 1 99  
 f g l 1940 D 18 6  
 f ear ll 1940 D 1636  
 f l f 1940 Dc 1613  
 h l l 1940 Ap 1 549  
 f b d b 1940 D 1831  
 l f rm b 1 40 f 1931  
 f ll D 1645  
 mpe 1 1940 D 166  
 1941 F b 4  
 f m l p ce  
 1939 D 1437  
 f f m 1939 D 1453

F t f f m dyla 1940  
 D 1768  
 t dyla 1940 D 1763  
 t t och t 1940 D  
 1738  
 k 1939 A g 927 D t 1135  
 1940 t b 75 D 1725  
 h ft 1940 D 1743  
 f f b l 1939 D 1454 1940  
 D 1781 1795  
 th t b 1940 D 1782  
 f f g 1940 D 1711  
 f f t 1940 D 1815  
 f f m 1939 Dec 1416 1940  
 J 845 O t 1393 D 1677  
 So tt ppa t 1941 Ap l  
 580  
 f h d 1940 D 1695  
 f h p 1940 D 1721  
 f h m 1939 D 1444  
 l d 1940 D 1646  
 h ft 1940 D 1639  
 ppe d 1940 D 1633  
 f k 1940 D 1763  
 f l g 1939 D 1454 1940 D c  
 1781  
 mpv J 1940 D 1796  
 t t f l f m c l f l  
 l g 1940 J 853  
 f m l l 1940 D 1799  
 f m taca p l 1940 D 1703  
 f l ca p l 1940 1695  
 t sal 1940 l 1830  
 f o c 1939 Ap l 467 1941  
 f b 21  
 f l c p c 1939 l  
 1445  
 f o s l 1940 D 1816  
 t l t 1940 D 1825  
 f pat l 1939 D 1454 1940  
 D 1771  
 f ph l k 1939 l 145  
 1940 D 1711  
 f d l l 1940 D  
 1682  
 h ft 1940 l 1669  
 ppx d 1939 l 1445  
 1940 l 1657  
 f b 1940 O t 1477 D 1628  
 1941 Ap l 372  
 f caph d 1939 D 1450 1940  
 D 1695  
 f p l 1940 l 1626  
 f h ld 1940 l 1613  
 l p c h l l k  
 1940 J 849  
 f k l l 39 l 1411  
 h l l 1941 Ap l 325  
 f p l 39 Dec 1416  
 f l 10 O 14 5 1941  
 A l 1 372

Fra t e s f t t l m t l 1940  
 l 1826  
 f t mpo l b 1941 Ap l 363  
 f t b l d t t p  
 1941 Ap l 503  
 h ft 1940 D 1781 1794  
 th h ft f l l 1940 D  
 1 82  
 p 1940 O t 1454 D c 1778  
 t b t 1940 D 1776  
 f t 1940 D 1835  
 f l 1940 D c 167  
 ppe l 1940 D 1656  
 f t 1939 Dec 1447 1940  
 D 1695  
 P l t 1940 D 1800  
 m l t d 1939 J 715 718  
 l t 1941 F b 205  
 l g c e f 1940 D 1604  
 pe 1940 D 1605  
 t t f 1941 F b 218  
 d th 1941 F l 206  
 h th 1941 F b  
 208  
 e g m t 1941 Dec  
 178)  
 t m t r v po  
 m l 1940 D 1597  
 g l d t 1940  
 D 1597  
 d mple c t d l y 1941 D  
 1731  
 t d t Ram t dt p t 1939  
 l 1558 1563 1940 O t 1504  
 F h g f t f h l f t  
 sal 1941 Ap l 497  
 t l d t f path 1940  
 J 691  
 F kh lm h f h ml  
 1941 Ap l 389  
 F l t f b l d j m g l  
 1940 l 68  
 F l b l c l g 1939  
 l l 150 1941 J 870  
 F l f k 1941 F b 57  
 f s 1941 l 21  
 t t t 1941 F b 235  
 C l 1939 D 1520  
 C l o c l 1941 F l 72  
 C l c e t l t h y p e  
 h d m 1941 O c 1249  
 C m l J d ca 1939 A g  
 88 906 1941 A g 1117  
 d c 1939 A g 881 899 913  
 l t ) f 1941  
 D c 1608  
 h l l 1939 A g  
 903  
 l 1940 Ap l 518



G t l l d g 1941 Oct 1333  
d m t m d h t l g  
h g 1941 O t 1338  
phth lm S H p th ad m  
t th th hyperthy d  
m g d 1940 F t 41  
mal g t t f m t 1941  
A g 1040  
pathog 1941 O t 1331  
Goldth t t l t pl t t  
1939 F b 98  
Go d t p h m t g t  
f 1941 J 933  
Go d t p h f n t l  
t bl d g 1941 O t 1448  
Go t my 1940 F l 223 2 4  
C hea m l 1939 F b 191  
Go orrh l pe t 1939 F b 193  
p d d y m t 1939 F b 194 1941  
D 1661  
pe th l b 1939 F b 192  
p t t bsc 1939 F b 195  
sem l l t 1939 F b 198  
t t f th 1939 F b 199  
G d g f ca 1941 A g 947  
C ft k f h d 1939 F b  
228  
p d l f l f f d  
eck 1941 F b 41  
p d p t p t ca 1940  
A g 1087  
G l m f ct 1940 J  
740  
g l 1941 D 1659  
m t g d g 1940  
Oct 1550  
G l cell t m f 1941  
A g 1206  
C d S H p th y ond m  
G y m l g f k  
1940 F b 129  
G th cr t f f t  
h l d hood 1940 Ap l 589  
G h t l f h d 1941 Ap l  
489  
C y col g p 1940 J 823  
G y m 1941 F b 67  
H l r f l l l p d d  
t 1939 A g 1032  
H y m t p g m t d 1939 Ap l  
459  
H l t d pl  
f 1939 F l 81  
g d 1939 F b 33  
l g 1939 F b 24 33 112  
J 721 1941 l b 169  
H l ed pe t f g l h r m a  
1941 J 885  
H m m oe 1941 l b 169

H m t g m l t pl t t  
1939 Ap l 495  
H d D p t t t 1939  
F b 238  
fl t t 1939 F b 234  
f t d d loc t 1940  
D 1695  
f ct 1940 O t 1457 1941  
F b 188  
J by p t d d  
f en bod 1941 Ap l 485  
fi t d d t y 1941 Ap l  
524  
J th l t 1940 Oct 1454  
p pl f t t m t 1941  
F b 188  
lymph g t 1940 O t 1465  
m g cal d t 1941  
F b 181  
pe t block th 1941  
F b 287  
f t l p l 1939 F b  
117 119 129  
pl t g y 1939 F b 2 7  
geo p p t f 1939  
D 1377  
t d pa d y 1939  
F b 242  
H l g g ca t f C l d l 1940 D  
1640  
H l p 1941 F l 48 51  
H t bl B m d f ca  
1939 J 670  
H d J 1939 D 1401 1941  
Ap l 311  
b l g phy 1941  
Ap l 314 320  
fi d d y 1941 Ap l  
52  
f t l d g 1941  
Ap l 357  
h l d 1941 Ap l 323  
th 1941  
D 1556  
loc l th 1941 D  
1552  
tm t 1941 D  
1623  
m l g t l v oe g th py  
1940 J 870  
pl t g y 1941 F l 37  
t F l 227  
p l j es 1941  
H d h f l g ph l g ph  
y g th py 1940 A g 1119  
pos p 1939 Ap l 363  
J 695  
H l g f d 1940 Dec 1859  
m l 1940 F l 229  
t m C l g y l 1940  
l l 225

## 1830 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

- H rt disease hes 1940  
 A g 929  
 hypa th d m m sq et d g  
 1941 O t 1233  
 pe t d t f k  
 1940 A g 1169  
 38 1940 A g 1129  
 th d bt t l thy d-c my  
 1940 Oct 1306  
 bleed g 1939 F b  
 152  
 f l g t hype thy  
 l m d g t l 1941 O  
 1365  
 p l th 1939 Ap l  
 361  
 les bd m l pa d  
 1940 J 753  
 t mpo d 1941 D 1596  
 d h t j 1940  
 O t 1481  
 H rtb ppe d t 1939 Ap l  
 330  
 H ppl ca thf j  
 1940 O t 1439  
 hock 1941 D-c 1669  
 H l m th 1939 A g 1056  
 H l m g h p j 1940 A g  
 1141 1146  
 th d g j 1941 A g  
 1057  
 H m go d th l m fbo 1941  
 A g 1156  
 H m g m l l 1940 J  
 703  
 f palm 1939 F b 237  
 H ma m 1939 D 1348  
 l 1941 Ap l 369  
 l b t 1941 F b 77  
 pe l 1941 Ap l 447  
 be 1941 Ap l 538  
 H m my l 1940 F b 275  
 H m t f l l g th l  
 p t ct m 1941 O t 1374  
 1378  
 bl dd m ged 1940  
 F b 66  
 l j y 1941 Ap l 448  
 h pa 1940 O 1371  
 H m pl g po t p 1939 A b  
 958  
 H m lyt j d pl m  
 1941 O 1453  
 H m media m 1941 Ap l 373  
 374  
 H m pe ca d m 1941 Ap l 375  
 H m h g mpl cat g th l  
 t my m g m 1941 O  
 1291  
 f l t t hock 1941  
 D-c 1667
- H m rth g d t sed pl p  
 t 1940 F b 195 1941 Ap l  
 459  
 d od l 1941 J 721 729  
 l l g th l p t t  
 ct 1939 F b 182 1940  
 F b 62  
 f m d 1939 D 1360 1372  
 k tr 1941 J 721 729  
 bd m l t m 1939 Dec  
 1430  
 b l y ra d ease p t  
 t m k 1939 A g 891  
 m f m h 1941  
 J 723  
 pep l 1940 F b 207  
 J 744 1941 J 673 721  
 729  
 p l th 1939 Ap l 362  
 th j 1941 D  
 1595  
 t y ld 1940 Ap l 575  
 po t hy d ct m ma g m t  
 1941 O t 1293  
 t be g 1939 F b 149  
 1941 J 865  
 ca m f t 1941  
 A g 1192  
 H m h g t d y j d  
 1939 F b 149 O t 1264  
 H m rth dect m j 1939 J 684  
 685  
 H m rth d 1939 J 669  
 ca m f l looked b  
 c l 1939 F b 204  
 H m th 1940 O t 146 1478  
 H pa p t d tm t  
 l h mbo t mbol m 1941  
 Ap l 393 395  
 H pa d 1939 A g  
 848 88  
 t l 1939 A g 862  
 l t t Ch 1939  
 A g 853  
 fl c f 1939 O t  
 112  
 H p t od od m 1939 A g  
 862  
 H bd m l lk pa f  
 1941 J 881  
 d ph gm 1940 A b 961  
 O 1480 1941 J 657  
 Oc 1385 1394  
 bd m l h p  
 p oa h 1941 J 660  
 h ph k l 1941 Oct 1383  
 1387 1389  
 g l 1940 J b 141  
 block th f 1941 F b  
 291  
 h ld 1941 Ap l 425

H rna po t pe t	pp t i t	H p t l	A my	d f	p t
1939 Ap l 372		b h f	phth lm	g	
m f ll g bd m l p		1941 D	1559		1941
t t pe t l pe		t	th p d		
t f 1939 Ap l 453		D	1695		
t g l t d th t t l b		N l 1941 D	1539		1941
t ct 1941 D 1611		m g	t f f t		
t m t 1941 Ap l 58		D	1720		
H iat f t rt l l d k		H t w t d	g	g cal f	
1939 F b 43 44 Ap l 475		t	1939 D	1385	
A g 945 1940 O t 1417 142		H gh m thod f		l y l d	
1428 1431 1941 J 889		1940 Ap l 586			
f t t cal 1940 Ap l		H m b t	f t d	1941 Ap l	
38		565			
H h ph g l t h		H m f t	1939 D	1444	
1941 J 883		l d	1940 D	1646	
H p mpl tg t tm t		h ft	1940 D	1639	
1941 F b 245		pp	d 1940 D	1633	
Hevyl so l t sept		H y m m th d f		t f	
1940 Ap l 420		1939 D	140		
H t h soph g l 1941 O t		H d t d f m m l bl d g		1939	
1383 1387 1389		F b 160			
H bb l mb l th d 1939		H y d d t	pp t	tg	
F b 39		t tm t	1941 F b 237		
H d d t pp t 1939 A g		H d t m th d f m		g	
1029		1939 Ap l 295			
H gh f q y t g y		H d l 1941 F b 18			
1939 D 1545		H y d ph l 1940 J 677			
H p th t g y f 1941 J		H y d ph t	sc p	d py	
895		l gr phy	1941 F b 144		
d l cat 1940 D 1724		pl t p t		f ll w	
g t l 1939 F b 3		1940 A g 1058			
d f m ty 1939 F b 131		H p gl m h p th d m			
f t 1940 D 1721		1941 O t 1251			
g d 1940 F b 75		H y p m h 1939 F b 155			
t l f t 1939 A g		H p ph m 1940 F b 72 1941			
927		A g 1173			
p t f t l p ly		H y p t l d f t t d		1941	
1939 F b 131		f m h p h d m			
g t d t pl t		O t 1225			
1939 F b 98		mp thect my f 1939 A g			
H h p g d ae 1939 O t		969 Oct 105			
1163 D 1557 1940 O t 1353		y h g 1941 O t 132			
H t m dph ph t M		H p thy j p t p			
d m 1940 J 723		1940 A 947			
llodgk d bl 1940		H p th d m typ cal 1941 O t			
Ap l 547		1231			
H fm t f ca m f		t d k case m g m t 1941			
t m h 1939 J 609 1941		O t 1303			
J 70		d g l l p bl m 1941			
f pept l 1941 J 68		O t 1357			
H d l m 1941 F b 1		mm		1941 O 1223	
H m g d t p t g t		l b d l t f			
f 1941 J 933		1941 O 1241			
H t 1940 F b 122		d g t l 1941 Oct 1365			
llosp t l C p N 1941 D		h g 1941 O 1313			
1534		h t l g h g l cal			
h l f 1941 D 1538		t 1941 Oct 1357			
H p l hp 1941 D 1540		ged 1940 F b 39 40			
m g m t f f t		l t t m l g f thy d			
1941 D 1715		gl l 1941 A g 1040			

- Hyp thy d m thy d 1941  
 O t 1243  
 p eop i d po t p t ca  
 d mpleat 1940 Ap 1  
 523 A b 941  
 p l l m k l t tm t  
 1940 O t 1303  
 q l l f t 1941 Oct 1369  
 t p t t s l  
 thy d t myf 1939 J 573  
 mpos 1941 Oct 1223  
 th pe test th ocl f  
 1941 O t 1228  
 th l gl l t m d  
 h t log h g 1941 Oct  
 1331  
 t tm t d g l l t 1941  
 O t 1255  
 Hypa t bol m y h g  
 1941 O t 1321  
 Hypo p l th wa  
 1939 Ap 1 359  
 H peth pa f et 1940  
 Oct 1471  
 Hypothy d p tthy d t m  
 1941 Oc 1298  
 Hy t eel my f ca m f p  
 t 1939 Oct 1326  
 l g pl t 1940 Ap 1  
 439  
 k l l eat f 1940 J  
 826  
  
 I r 1939 F b 211  
 g l 1939 F l 164 Oc  
 1171 1940 J 740  
 Il l b t g dia b  
 1940 Oc 1543  
 Il oc l 1939 F b 211  
 Il l t my f d mp f  
 l 1941 A g  
 1147 1148  
 Ileo m t p f h  
 l t l 1939 J 629  
 Il t m l fl m t y l  
 1939 Oct 1171  
 Il t mpl f p  
 p d t 1939 Ap 1 397 407  
 415  
 p l y t d mp 1939  
 F b 163  
 Imm b l a  
 d f m t 1941 Ap 1  
 571  
 Imped gl h y p h J m  
 1941 Oct 1252  
 l p t g tg t tm 1941  
 F l 238  
 Imp sed d g d eq pm  
 1941 Dec 1751  
  
 I d d 1939 D 1350  
 I f ppe dect my 1939  
 Ap 1 367  
 d h l g l 1940 D 1860  
 I bl ca 1940 Ap 1 531  
 I dgest pp d t 1939  
 Ap 1 39  
 I dg m t t f k d y f t  
 1940 O t 136  
 I d t l d t mm d iat m  
 g m t 1941 Ap 1 519  
 I f f p ly See P l m l l  
 I f t f l g l pe t  
 1941 J 83  
 I f cted d 1939 Dec 1365  
 1363 1941 D c 1730 1739  
 I f t t y t l  
 1941 F b 234  
 l 1939 D 1391  
 g th p 1940 A g 1135  
 b p k g m 1939 D c  
 1348  
 h t bl eding 19396  
 F b 154  
 g b ll 1939 D 1357 139  
 h m l 1939 Dec 1366 1381  
 m cro- ph l t ptoec  
 1939 Dec 1396  
 t phyl h ld 1940  
 O t 1511  
 rg cal 1939 D c 1375  
 I f l t h m pl f g  
 t 1941 J 917  
 f fl mm t y d s p l  
 bleed g 1939 F b 158  
 I g th wa 1940 F b 141  
 h ld 1941 Ap 1 425  
 h h phy tech 1941 J  
 883  
 I J t m f g el d  
 b sa 1940 F b 135  
 f g lh 1940 F b 150  
 f t m l h m rth d 1939  
 J 676  
 f p l p f d t m  
 1940 J 833 834  
 f p 1939 J 689  
 f t g m l l wa 1940  
 J 666  
 t uco 1939 D c 1541  
 I J ed t port f 1941 D  
 1767  
 I J bd m l f t d  
 m 193 D 1423 1432  
 thl 1940 O 1439  
 l 1941 Ap 1 367  
 1941 Dec 1574  
 b k 1941 Ap 1 524  
 bl dd 1941 D 1649  
 b d p l d firs d  
 1939 Dec 1401

1	h t t m t 1941 Ap 1	I t t l b t t t 1940
371 Dec 1593		J 735 781
merg t m t 1940		mlt y f 1941 Dec
O t 1473		1611
h l d b r t h g l p a 1940		dec mp 1939 F b 161
J 825		d f f t l d i a g 1940 Oct
trap l m l t g t		1292
bd l t m 1941 Ap 1		d b l f m t b t t b
417		1941 Ap 1 488
y 1941 Ap 1 331 523		g d 1940 F b 13
f t 1941 Ap 1 495 504 524		t d l t b l 1940
h d b y p t d		A g 1200
f g b o d 1941 Ap 1 485		t l b t t 1940 J
head 1939 D 1401 1941 Ap 1		782
311 323 357 522 D e. 1623		t t p p p e t p
S l H d j		p e t p p a t 1941 O t
d t u a l m m d t m g m t		1465
1941 Ap 1 519		t b f i s t g d g
l t 1941 Ap 1 526		1941 J 829
l d y 1939 A g 1033 1941		I t t l d f t u a l d g
Ap 1 443 D 1647		1940 O t 1291
l b t h 1941 D		m l l t m f 1941 Ap 1 409
1578		I t b d m l p t h f
l a r y g l 1939 Dec 14 9 1482		t h t 1940 A g 925
1941 D 1575		I t u a l j 1941 Ap 1 311
m l l f l 1941 D		h l d 1941 Ap 1 327
1583		p e t h f t h t
se d se 1941 Dec		1940 A 923
1573		p sed head j
l 1941 D 1563		1941 Ap 1 313
th ped m g m t m b t		I t p t c a l b a c s e d y
1941 D 1689		f l l w g p p d t 1939
p p h l 1941 Ap 1		Ap 1 43
469		d g p p d e e t m y 1939
m a l l t t 1941 Ap 1 409		Ap 1 369 385
f t f t d b l d		p e o p e r t 1940 A g
1941 Ap 1 535		1039
p l d 1939 Dec 1401 1941		I t t h g t h h y p e r t h y
Ap 1 433		d m g e d 1940 F b 41
t l 1941 Dec 1660		I t h h 1939 A g
t l 1941 Dec 1649		1053
I t g l t m		N l p t 1941 D
f m 1939 D 1380		1554
I R l t t c ( w		f l d t h p y h k 1941 D
b 1939 Ap 1 552		1769
l l f l t b l l g		d t p p e t 1940 A g
1941 Oct 1450		913 918
I t c o d l f t e s f f m		th p y 1940 A g 1093
1940 D e c 1763		I t b a t t e s t l d l l m
I l r v l l o c k 1941 F b		t l l 1941 Ap 1 588
288		I t s s s e p t 1940 Oct 1506
l o c h t f r a e s 1940		m t g d g n o s 1940 Oct 1542
Dec 1738		I d b l o o d h y p r t h y d m
l e r l l d k h u t 1939		1941 Oct 1250
F l 43 44 Ap 1 475 1940 Oc		h p e t h d m 1941 Oct
1417 1422 1428 1431 1941 J		1255
889		b t e e t g f p t 1941
l l d s e m p g h		O c t 1259
p h 1940 A g 1116		m p l c a f m l g c o t
l o n d p t h m b d f y		e d s e 1940 Oc 1310
1940 A g 1208		p e r a b l c a s e s 1941 Oct 1260



- Iod hyperth d m p p  
1941 Oct 1258 1308  
p eope t 1940 A g 943  
1941 Oc 1 56  
ec rr t cases 1941 Oct 1 57  
th rape test f h p rthy J  
1941 Oct 1228  
I p laps f 1941 F b 5  
ph r paraly 1941 Ap 1 33  
I l post 1941  
Ap 1 332  
therap curabl ca 1940  
Ap 1 533  
Irrad t See 1 R t d  
R d m  
J t m a f 1941 Ap 1 333  
Irr g t l l d d f t  
thral prot t meet 1939 F b  
183 184  
Irr l l 1 1939 Oc 1141  
I m hof f l l v d g t 1930  
Oc 1 65
- J g t t 1941 J  
65 66  
J l bled g d y 1939  
Oct 1264  
h m l p ogent 1941  
Oct 1453  
b t t 1939 Oct 1263  
d p cooperat 1940 A g  
1223  
p d p n t perat ca 1940  
A g 1005  
J m J s m 1941 A g  
1018  
a d f 1941 Dec 1583  
J J l feed g f m l f 1940  
A g 1219  
l 1941 J 6 6 43  
h m r h g 1941 J 72  
J J m f p l y ? 193  
F l 161  
Jua g r m 1941 J 76  
766  
J j fir t d d  
1941 April 526  
hl 1940 Oct 1444  
J g l p ct 1940 A g  
1105
- K 1939 Ap 1 368  
375  
hell perat f h l l alg  
1939 J 723  
K l d f f 1941 F b 39  
oe tg t m 1941 F b 240  
l t c lag f h h l v o 1941  
Ap 1 334
- K rat th d d seac 1941  
Oct 1315  
paralyt ca 1941 Ap 1 334  
K ra oc J t 1941 Ap 1 334  
kerat se e cal 1940 F b 119  
125  
barrh 1940 F b 118  
se l 1940 F b 118  
roe tg t eatm t 1941 F b  
242  
K d y b c s 1941 Dec 1641  
1644  
B fl p fec 1941  
D 1640  
cal l 1930 Oc 1285  
b l 1941 Dec 1643 1644  
m t 1940 Ap 1 39  
d b l m t 1941 Dec 1645  
d r o 1940 Ap 1 295  
l se f l f ual d e  
1940 Oct 13 7  
pera e k ed ct f  
1940 A g 1187  
f t 1940 A g 1189  
Oct 1360  
f les 1940 Ap 1 95  
lect 1941 Dec 1640  
l r 1939 A g 1033 1941  
Ap 1 443 Dec 1647  
les 1940 O 1290  
mal gn m 1941 A g 1173  
mov tl t cal ca h zat  
ca e p d ca d 1941  
F b 140  
pera es h ual 1940  
A g 10 3  
p d p n p ra ca 1940  
A g 1049  
pa h yma d oca f  
ad t 1940 Ap 1 411  
partial sec f m l l  
1 39 Oc 1292  
p l m f 1940 Ap 1 41  
sec 1940 Ap 1 290 1941  
Dec 1644  
oe g d pera g bl  
1939 A g 1041  
sol t cal l b  
1940 Ap 1 333  
g cc c p 1940  
Ap 1 2 7  
be l 1940 Ap 1 394 471  
1941 Dec 1640  
scop 1941 F b 144  
m ged 1940 F b 0  
klapp se scol 1939 F b  
140  
K e rthn rg f 1941  
Ap 1 593 J 898  
f f es 1940  
Oct 14 0

K	fl	d f m t	t d	La	g	p t	f pa ly	h p
t	pl t t	f 1939 F b	95	g	1939 F b	99		
f	tu b t	1940 D-c	1763	La	y g	l rv ec	t j	t
	athl t	1940 Oct	1450	thy	dect my	1941 Oct	1295	
l	g m t	j	1940 Oc	v t	l p lap	f 1940 J		
	1450 1453				710			
t	h d t	g d	1940 F b	La	y g t m	f ca ma	1941	
97				A g	1032			
m l	t l g	d pl m t		L	y g t	hyp t ph	bgl tt	
1940 O t	145			1940 J	707			
K	ee-ch t po t	1939 J	671	La	y g sc p	types 1939 J	818	
K	t ty g	1940 Dec	1864	La	y g	ps d t l cat	f	
Ka	kl toeth	d 1941 Ap l		1939 J	817			
488				Lary	ca m	1941 A g	1030	
hoch	d t	f l l t	f		bl	1940 Ap l	542	
h	ld	1940 D	1623	p t	g l th	f		
K	hl d se	1941 Ap l	498	1939 J	588			
K	d l p t	m d f d f		t	1939 D	1478		
h	l g l	1941 Ap l	617	t m	b g	1940 J	697	
K	l	ged	1940 F b			1941 D	1575	
l l l				Lat	l l g m	j	1940 Oct	
K	og t d t	pl t f ec			1450			
t	d locat	f p t l l	1939	La	g g t	po t p i	1940	
f l	98			A g	994			
				La	t	d t bl l	1939	
				O t	1143			
l	at	th d f pa	t b l	L	db tt	d t f t	f	
jeet	f l h l	1939 D	1575	f m	l k	1940 D	1731	
Lab	b ec h p	se t t	1939	L	g f ct es	1940 D	1781	
F b	249				mpo d	1940 D	1796	
Laby	th d t t	j	1941	t t	f calf m sel	f l		
D	1576 1578			l	g	1940 J	853	
Laby	th t g	1940 J	72	t g b	g	1939 F b	69	
La	i d d	1939 D	1358	p t	f t l p ly			
L	t f t	1941 Ap l	311	1939 F b	131			
	h l l	1941 Ap l	327	p	ff m	1939 Ap l	462	
f		p m y p	1939	pl t	t mpo ed	1941 D		
D	1472				1713			
f	y l d	1940 Ap l	578 580 581	h	ged h l f	g A my	1941	
1941 F b	3			Dec	1690			
f	k	1941 F b	56	l t	pl t t	1939 F b		
f	lp	1941 Ap l	522	79	Ap l	493		
	h l l	1941 Ap l	325	t m	ih mb			
f	k	h l d	1941 Ap l	p lm	y mb l m f l l	g		
L	i	f	1940 Ap l	1941 Ap l	383 396			
583				l	h k R f g			
La	m	h d l se se	1941	1940 A g	1089			
Oc	1315			m	J fied	K d len	pe	
La		t l m t		f	1941 Ap l	617		
d	l f	1940 l l	259	Legg	pe	f pa l	h p	
L	k l h h lm	h d l se se		g	1939 F b	99		
1941 O	1315			l	my m	f t u h	1941 J	
Lah	p l l fl p p et	f		711	716 725			
f l	d l	1939 J	702	Le	sa m	f t m h	1941	
	bd	p l se		J	703 725			
l	39 J	657		L	mm	t	p l	
lam				h	u	1941 J	685	
l		1939 F l	46	Le	j es	1941 Ap l	343	
f	p l cord	j	1939 Dec	Leo	u	m	1940 J	6 8
1420	1940 l l	2 8	1941	Le	k u a f	rm	1941 Ap l	333
A l	440			Le	k pl ku	bed	1940 F b	120

## 1834 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

- Iod hype thy i m p e t p  
t 1941 Oc 12 8 1308  
p p rat 1940 A g 943  
1941 Oct 1256  
ec rr ca 1941 Oct 1257  
th p t test f hyperth t  
m 1941 Oct 1228  
I p l p e f 1941 F l 5  
ph pa ly 1941 Ap l 33  
l d p e corn 1941  
Ap l 332  
th p ll ca er 1940  
Ap l 533  
I d t See l Roe t d  
R d m  
y ma f m 1941 Ap l 333  
Irr g t bl dd f  
th l p t esect 1939 F b  
183 184  
Irr ll l 1939 Oc 1141  
I y m th d f ll l g t m 1939  
Oct 1265
- J 65 66 1941 J  
J l bl ed g d cy 1939  
Oct 1264  
h m ly p oges 1941  
Oct 1453  
b l t 1939 O t 1263  
d t p p t 1940 A g  
1223  
p d p o p e ca 1940  
A g 1003  
J m l b t t m 1941 A g  
1018  
d f 1941 D 1583  
J J l f ed g f m l f 1940  
A g 1219  
f 1941 J 676 743  
h m r h 1941 J 722  
J t m y f pa ly l 1939  
F l 161  
Jua g t m 1941 J 765  
766  
J unt J s f d d ry  
1941 Ap l 526  
hl t 1940 Oc 1444  
J g l p et 1940 A g  
1105
- K u 1939 Ap l 368  
375  
K ll p t f h ll lg  
1939 J 723  
K l d f f 1941 F b 39  
oe g eatm 1941 F b 240  
K rat lug phth lm 1941  
Ap l 334
- K t th l d e e 1941  
O t 1315  
pa lyt ca 1941 April 334  
K toc j et t 1941 Ap l 334  
F rat ses rse l 1940 F b 119  
125  
bo h 1940 F b 118  
se l 1940 F b 118  
oe tg tm t 1941 F b  
242  
Kud y b cress 1941 Dec 1641  
1644  
B ll p t lee 1941  
D 1640  
l l 1939 Oct 1285  
ca b l 1941 F b 1643 1644  
m t 1940 Ap l 39  
d b d m t 1941 Dec 1645  
d 1940 Ap l 296  
d f d f l al diag  
1940 Oc 1357  
pe t k ed ion f  
1940 A g 1187  
f t l 1940 A g 1188  
O 1360  
f t l 1940 Ap l 295  
lec 1941 D 1640  
J 1939 A g 1033 1941  
Ap l 443 Dec 1647  
les 1940 Oct 1299  
mal g t m 1941 A g 1173  
bl t l h  
t se p l j st dy 1941  
F b 140  
paratio h u f 1940  
A g 10 J  
p d p o p e ca 1940  
A g 1049  
pa h yma d oc ma f  
f l 1940 Ap l 411  
pa al ec f m l f  
1939 Oc 1292  
pel m f 1940 Ap l 412  
t 1940 Ap l 290 1941  
D 1644  
t d t p e t g bl  
1939 A g 1041  
vol cy t cal l h  
1940 Ap l 333  
g ec p 1940  
Ap l 287  
t h l 1940 Ap l 394 471  
1941 Dec 1640  
c p 1941 F b 144  
m g d 1940 F b 70  
Kl pp se l 1939 F b  
140  
K h u s k f 1941  
Ap l 593 J 898  
f sel es 1940  
Oc 1450

M h	O h	t t f	se	M y	p t f d lt d pa
1939 D	1536			ly	1939 F b 123 124
M l g	f	soph y	1940	t d t	pl t t f t l p
F b 153				lg	1939 F b 83
f k	g d	1940 F b 124		M y	f pp h t t
M l g	y f ca	g d g f		1940 Ap 1 3 8	
1941 A g 947				M y R bso	h p t d g
g d t l cal b h				1939 A g 859	
1941 O t 1476				M A th	p t f g l
M l g n	t d	ff t ph cal		h b ia	1940 F b 146
t t f p t t	1941 O t			M B m	1939 Ap 1 368
149				375 449 450	
tent f	l m t d			M t t my	1940 Ap 1 381
blty	1941 O t 1481			M t t	h ld 1940
diat	l tuo f	1941		Ap 1 379	
O t 1490				M k l	d t l m 1940 O t
p p t	d cat	d		1501	
l m t t	1941 O t 1488			Med cal C	p A m t
g dgr with h t t				u	1941 D 1688
1941 O t 1474				N y	1941 D 1533
g cal t tm t ymp m					g t 1941 D 1533
1941 A g 947				M d l l	bia t ma 1940 J 655
t eat t d blt f t				1941 A g 994	
fl g	1941 O t 1473			M g l	1939 O t 1163 1940
M l l	f t b t 1940			O t 1353	
D 1799				M g l	t 1940 Ap 1 327
M l t foot	1939 F b 24			M l a m	1940 F b 122 132
M l m	se l 1941 J 895			M e	y d m 1940 J 721
M h t p t f	p			M g	p l fib f sc t
l pse	1940 J 8 6			M d t	1939 Ap 1 483
M d l	d t pt			M g ma	1940 J 654 657
1940 Ap 1 4 4 499 1941 D				1941 A g 987	
1642				b l	1941 A g 991
M p l t f y t 1941				t l m	1940 J 681
F b 153				pt r	1941 J 904
M h f t	1941 Ap 1 495			b l	t 1939 J
M D C p m d cal se	1941			727	
1541				M p	g t t f 1941 A g 987
M Oct 1288	py el m l g	1939		M g t	p t h d j
M O t	thl j	1940		t b l p	ph ect my 1940
1441				Ap 1 402	
p t t	1940 Ap 1 374			M m t	h g u f l ma
M t t my	d cal f ma			M g m t	1941 O t 1443
1939 J 755 1941 A g 1063				M p se	t 6 l u y g m
1065				1941 J 872	
M t	1941 F b 73			M h g u	1939 F b 155
M t d	d t d se se f al			M b g ca	1941 J 865
pa ly f m	1940 J 685			M	1939 F b 150
M dec my	med d			M t l d	g col g y
cat	1941 F b 19			1940 A g 1034	
M Sm l l V	m			M och m	r y pt
1939 F b 258				1940 Ap 1 421 499	
M l l y	cal			M se t l	d ff tial diag
m	1939 Oc 1243			os	1940 Oct 1286
M l l f	l g y m l t	1941		lymph d t	m l t g
D 1583				t ppe d	1939 Ap 1
d	base h			307	
p l	1941 D c 1591			th mb	ged 1940 F b 8
ex mba	1941 D c			Met bol h m	pt r y 1941
1587				Oct 1243	

- Le k pl kia f ry 1939 Dec 1476  
 f l ry 1940 J 04  
 f l'a ged 1940 F b 111  
 L j ry t gla m f ll g 1940 F b 215  
 L d l g thy d d se se 1941 Oct 1318  
 L g m t unj es f k ce 1940 Oct 1450 14 J  
 L m t m fla m hypert phy f sci at ca d 1939 Ap l 481  
 L g l tracap l f f th d t thy d g ry 1941 Oct 1278  
 f saph 1939 Dec 1538 1540  
 L p ma f 1940 F b 124 1941 A g 976  
 h gh f eq cy rr t 1939 D 155  
 p th l m squam ll 1940 F b 124  
 p pe lectio f 1939 Dec 1388  
 L p od l m l ry rt b l d kl 1939 F b 45  
 se l ca 1939 Ap l 480  
 L pom f b ea t 1941 F b 73  
 L er bac diff ial diagn 1940 Oct 1293  
 ged 1940 F b 47  
 ca ma ged 1940 F b 48  
 f l f ll g pe t f b et j d 1939 O 1269  
 pa t thy dect m 1941 Oct 1304  
 g j ged 1940 F b 47  
 Lobect my d'a 1941 Dec 160  
 f b h ect 1939 J 745  
 f h p lm ry bac ss 1941 Ap l 605  
 Lobel hyd ochl f ph'ia f born 1939 Ap l 555  
 Local th sa See l th l l 1939 J 649  
 Loop col m f bd m l 1939 F b 129  
 L m l p'raly 1941 F b 62  
 L d g 1941 F b 62  
 L mba p ct ry rt hral d kl 1939 F b 45  
 sci at ca 1939 Ap l 480  
 L mbosacr l rth 1940 Oc 1436  
 rth od H bb 1939 F b 39  
 l ba k pain 1939 F b 36  
 rt bra tru t ral sa se t ca d 1939 Ap l 484  
 L d locat 1940 Dec 1701  
 L g bscs 1941 Dec 1601  
 b h sc p 1939 J 81  
 ch t l es 1940 Oc 148  
 l bect my f 1941 April 60  
 ca m bl 1940 Ap l 543  
 p mary 1940 F b 163 1941 A g 1083 Oct 140  
 bro ch se py 1941 Oct 1434  
 compl ca ga t gery 1940 A g 1001  
 post pe t 1941 J 815  
 y g th py 1940 A g 1130  
 d se se bd m l perat m thod f ed g r k 1940 A g 973  
 ed ma y g by po l p 1940 A g 1126  
 po t pe t 1941 J 826  
 f mbol m 1941 Ap l 544  
 f ret po perat 1941 J 8 J  
 ma ll pse po perat b ch se p pra 1939 J 82  
 t b los S T b l p l m na y  
 t m 1941 Dec 160  
 m b h sc p 1939 J 821  
 L p le ged 1940 F b 123  
 tymph d t rv cal 1941 F b 31  
 m se t m l g l ppe d t 1939 Ap l 307  
 oc g t ea m 1941 F b 238  
 be cul 1941 F b 60  
 t mph g t f h d 1940 Oct 1465  
 g tm 1941 F b 238  
 Lymphocy hyperth l m 1941 Oc 1251  
 L mpho-ep h l ma f nasoph rvn 1940 F b 154  
 l mphogra l m g t 1941 Dec 1659  
 fi l 1939 A g 1030  
 L mph sa coma rabl 1940 April 547  
 f soph ry 1940 F b 155  
 1941 A g 1029 1030  
 M og so praec 1941 A 1167  
 M g ll be 1939 A g 10 6

- A y esth sa 1941 Dec 1545  
 m g m t f f t 1941  
 D c 1703  
 M d l D p t m t g t  
 1941 Dec 1533  
 med cal pe so l f l t f  
 t g 1941 D 1538  
 th g r y 1941 D 1605  
 f g cal u g y 1941 D  
 1637  
 1941 O 1783  
 A k f l p t my 1940  
 Ap l 560  
 l p d cl k g ft f 1941  
 F b 41  
 mal g t l oe tg ther  
 p 1940 J 870  
 m g y f 1941 F b 55  
 p t h f th t  
 1939 J 583 1940 A g 923  
 Needl b p ft m 1939 Ap l  
 519  
 N se f t S G h  
 Neoa ph r y t p  
 t 1940 Ap l 422  
 ph t my f d ca m f  
 k d y 1941 Aug 1174  
 f t b l f k d y 1940  
 Ap l 398 400  
 f W lm t mo 1941 A g  
 1177  
 t p 1940 Ap l 288  
 ph t g 1940 Ap l 296  
 p l th S C l f l  
 ph l th t my 1939 O t 1291  
 ph p g y 1940 Ap l  
 296  
 ph py l l th t my 1939 O  
 1290  
 ph t m t pt 1940  
 Ap l 293  
 t b 1940 A g 1056  
 ph t m p 1940  
 Ap l 293  
 ph t t m f p th l m  
 f l pel 1941 A g 1176  
 r v bl k 1941 I b 281  
 p bl ca 1940  
 Ap l 536  
 se th l f tal g cal  
 pa 1940 J 685  
 r v lcoh l j f t  
 bl p 1939 Dec 15 0  
 j t p t 1939 A g  
 95  
 p l l j 1941 Ap l 469  
 g cal pa 1941 Ap l 473  
 p t t h f h  
 f 1940 A g 9 0  
 p p t d 1940 A g  
 910  
 lg h f m ect n f  
 po t p l t f  
 1939 O t 1 95  
 t g m l 1940 Ju 663  
 th sa l 1940 Ap l 367  
 ect my p esa l f p  
 m r y d y m h 1941 J 855  
 N t p t p t 1939 A g  
 955  
 bl t ma f d l 1941 A g  
 1163  
 N l t y th sa d ff t  
 t d f m hyp thy d m  
 1941 O t 1 27  
 y h g 1941 O t 1320  
 ocyt m f d l 1941 A g  
 1163  
 fib m f l y 1940 J  
 714  
 g bl dd y to py  
 1941 F b 139  
 log d t po t p t  
 1939 A g 955  
 m 1941 Ap l 474  
 ma t 1940 J 634  
 1941 J 906 A g 999  
 f ll w g pp d t my 1939  
 Ap l 372  
 N g cal t q m t  
 1941 D 1623  
 Nev p g m t 1940 F b 121  
 N b m usc t f 1939 Ap l  
 547  
 se f t k 1940 A g  
 1209  
 p f h d p l  
 1939 F b 128  
 N l p t f h b t l d l  
 t f h l d 1939 F b 66  
 N d 1941 J 791  
 p eg 1940 F b 252  
 d h p l m  
 med cat 1940 J 624  
 N se ca m 1941 A g 971 976  
 1009  
 m g y 1941 F b 21  
 pe t h f h  
 1940 A g 924  
 t m t d 193 Ap l 467  
 j 1941 D 1573  
 N sebl ed 1941 F b 22  
 N l p l po p f 1939  
 Ap l 476 1940 Oct 1417 1422  
 1423 1431  
 N pe ca f p l th 1940  
 J 647 1941 J 804  
 N se C p N 1941 Dec 1534  
 t l f  
 j d 1941 Dec 1526  
 N gm l l l  
 1941 Ap l 360

- M t bol ra basal hyperthy  
 d m 1941 Oct 1241  
 M t bol m created h r d  
 ca see 1941 Oct 1243  
 M ca pal fra es 1940 Dec  
 1703  
 M t t sal b d F b g mf  
 t 1941 Ap 1 497  
 M tat t uc 1939 F b  
 28  
 M h m ry t sept  
 1940 Ap 1 423 499  
 M th l bl ry t sep  
 1940 Ap 1 421  
 M t h g 1939 F b 15  
 be g ca se 1941 J 86  
 M tyca f local esthesia 1939  
 A g 10 5 1941 Dec 15 1  
 f p l esth a 1941 Dec  
 1547  
 M oc ph l 1940 J 677  
 M t tw 1940 Ap 1 491  
 g t t d ce 1940 Ap 1 497  
 pa f l 1940 Oct 1371  
 M d l ca d seases t 1941 F b  
 13  
 M dp lm pace feet 1940  
 Oct 14 0  
 M kul pe t f rg nal l  
 1940 J 742  
 eect f ca ma f col  
 1939 J 637  
 M l t rg ry mpos m 1941  
 Dec 1523  
 f d b h S geo Ge  
 l 1941 Dec 1523  
 M ll Abbo be 1940 J 782  
 1941 Ap 1 588 Dec 1614 1616  
 M rg ry mpos m 1941  
 F b 1  
 M ed t m f ph ry 1941 A g  
 1029  
 M occa k m f t i  
 bl eding 1941 Oc 1443  
 M l h ry pgm ted 1939 April  
 4 9  
 h d t d f m bleed g 1939  
 F b 160  
 pgm ed h gh f eq y  
 1939 Dec 1553  
 ged 1940 F b 121 132  
 M g mery trap 1939 Dec 1369  
 Moo p f t f f m ral  
 eck 1940 F b 8  
 M ga l t 1939 Dec 15 1  
 M schro t p f p lapse f  
 d ect m 1940 J 836  
 M th l er l f g l  
 1941 F b 48  
 mal g t t m rs 1941 A 1017  
 a j es 1941 D c 1574
- M oc l f era ial a l 1940  
 J 681  
 M co m mbra es p eca er l  
 h gh f eq cy rr  
 1939 Dec 1552  
 polyp f 1939 Dec 1475  
 M scl h m t g t pl t  
 1939 Ap 1 49  
 mbal f fow 1939 F b 101  
 pl t es f h b ual d locat f  
 h ld 1939 F b 63  
 tears hl 1940 Oct 1442  
 M cl pl t t g f ppe  
 d ct my 1939 Ap 1 368 375  
 Mya d seae 1939 Oc 1163  
 Myalgia f eck 1941 F b 63  
 My l ma d h lial 1941 A g  
 1156  
 m l pl 1941 A g 1156  
 f ul lt 1940 J 683  
 My m f 1940 Oct 1381  
 M os t fica hl 1940  
 Oct 1443  
 ma ca 1940 D c 1664  
 My go m 1941 F b 14  
 My ed ma po t pe 1940 Oc  
 1303  
 M ia f b t 1941 F b 73  
 f l a 1940 J 710
- N 621 p eopx 1940 J  
 b ct 1941 F b 24  
 passages ma 1941 A  
 1009  
 pt m lsc 1941 F b 26  
 d flectio 1941 F b 26  
 N opharyn ca ma 1941 A g  
 1013 10 7  
 fib ma 1940 F b 155  
 m lgn 1940 F b 153  
 A t I R a h C l S b  
 m ee l d M l l ul  
 S gery 1941 Dec 1583  
 N se d t ppe d  
 1939 Ap 1 3 9  
 rabl 1940 Ap 1  
 53  
 p g y 1940 F b 26  
 p l h u 1940 J  
 6 5 634  
 N 1 h p l 1941 Dec 1539  
 manag m t f fract 1941  
 Dec 17 0  
 N 1 Med cal School 1941 D  
 1538  
 N 1 R se 1941 Dec 1542  
 l b ca pal f t  
 1940 D c 1693  
 sal f 1940 Dec 1830

P	ry t t d	1940	I a	l n se ca m	1941
Oct 1371			A g	1011 1021	
t t bl t h l j t fo			Pa thy d t a t f t j		
1939 D 1569			t t y 1940 A g 950	1941 Oct 1443	
l f t l f hock	1941		1298		
D 1668			I ert b l lcohol j t	1939	
538	bl ca er	1940 Ap l	D c 1575		
scat 1939 Ap l 475	Aug 943		P t l dm t t t f f d		
t rt b l d k l d			1940 J 883 892		
1939 F b 43			I t l f m l g j	1940	
P l t l ft	1940 Ap l 593		J 677		
m dt m d a m f			I y hua	1940 Oct 1458 1459	
1941 A g 1022			oe tg t eat t	1941 F b 39	
P l m h m g ma f	1939 F b 237		P t l l d locatio ec t t d		
P l p b l f r d z hyp			t pl t t f	1939 F b	
th d m	1941 Oct 1318		95		
P t g l arth d	1939 F b		fra t	1939 D 1454 1940	
133			D 1771		
P out t m	1941 A g 1085		I l bsc se d ff t l l uag		
P ca c m	1939 A g 888		dt tm t	1941 F b 93	
th bl d t b t i n	1939		f l l w g pp d t	1939	
Oct 1270			Ap l 425		
P e t t f t a h m l i g			d mm t y d t		
ca	1941 J 719		bl ed g	1939 F b 158	
P t t t	1940 J 747		p t p l m y mb l m		
h m h g c	1940 Oct 1299		lt	1941 Ap l 403	
pa	1939 Oct 1253		lt g y f	1940 J 823	
t d w th g l l bl dd d se			P l f m l c m l		
1940 J 796			bl	1940 Ap l 545	
P p l l du d l ea ma of	1941		t m	1940 Oct 1381	
A g 1117			P t f t l p l		
P p l l m f bl dd	1940 Ap l 412		1939 F b 131		
g d	1940 F b 66		P bl k th ca	1941 F b	
l b t	1941 F b 69		291		
f	1939 D 1476		h l	1941 D 1659	
f l y	1940 J 711		p th l	1940 Ap l 416	
P t f ea d m	1941 Feb		l t l	1941 Dec 1659	
14			P t th l od m f		
P h h t bl t j	1940		h	1941 D c 1554	
O t 1440			Peptoc l	1941 J 671 679	
P h ma f l g d th g h	1939		bl ed g	1940 I b 207 J	
Ap l 462			744	1941 J 721 729	
g g l m	1941 A g 1164		Dec 1619		
l y B l l	1940 J 686		mp l cat	1941 J 674	
f l g cal p	1940 J		t et	1940 A 1212	
585			d ff t l d k	1940 Oct	
gl med	1939 Ap l 493		1285	1941 J 669 674	
cg f h p t d pl t			m l y f	1941 Dec	
t l	1939 F l 98		1619		
pc ph l j y c			b y f		
1941 J 472			l b t ct mpw p y		
f l See f l			med cal m g m t	1941	
1939 A g 258			Oc 1495		
l ju d p	1939 I l		f es ph g l f k		
93			1941 J 727		
po pel l sc	1939		perf ted	1940 J 46 57	
f b 315			1941 J 674	D c 1620	
l l t l	1939 t b 161 Ap l		p bl m f	1941 J 665	
397 407 415			b t l k	1939	
			J 667	1941 J 682	



## 1840 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

- O p t f d l t d paraly  
1939 F b 123  
f p a l h p g 1939  
F b 99 Ap 1 493
- Ob t g 1940 A g 1126  
sed t 1940 A g 913  
m 1940 F b 249 259
- Oc p t l r l h l ject  
1939 Dec 1575
- Olec fract es 1939 Dec 1445  
1940 Dec 1656
- Ol th p l m y t b l  
1940 Oct 1496
- Olgod d ogl m 1940 J 655  
1941 A g 994
- Olg ia 1940 Ap 1 506
- Om t m t rs f d f f l ual diag  
1940 Oct 1286
- Op t k ca dia d sease  
d t f 1940 A g 1169  
l d se se ed l f  
1940 A g 1187  
d h l g f t m C  
( t m d) d 1940  
F b 225 2 9 231  
f e 1939 D 1375
- Ophth l m a y m p h t 1941 Ap 1 346
- Ophth l t A m h p l  
g t 1941 Dec 1 67  
g r A m y 1941 Dec 1559  
t m a z g 1941 Ap 1 348
- Oph h l m plegia thyr d d se se  
1941 Oct 1319
- Op t rabl 1940  
Ap 1 531
- Op ph mport  
diag f f bl b m  
1941 J 903
- O l c m bl 1940  
Ap 1 541  
h h f q y t 1939  
Dec 1555  
d vase m d se es 1941  
D c 1804
- O b l ca ma h g h f eq  
t 1939 O c 155
- O h ual ca m m ged 1940  
F b 130
- O t t m t f m p d f  
1941 Dec 1530 1698  
f d 1941 Ap 1 571  
Dec 1 28 1743
- Orth ped j es m g m  
mbat 1941 Dec 1659
- Orth ped g y y mpo m  
1939 F b 1
- Orth ped cs m l t a y I -11 D  
1685
- O l fra t 1940 Dec 1816  
t be ty 1940 Dec 18 5
- O t b ual t m 1939 F b 26
- Osgood d se se 1940 Oc 1454
- O t t f ual l 1940 J  
678 679 680
- l g f C r r e 1940 J 853
- O t rth t f p b k pa  
1939 F b 36 Ap 1 483
- Osteoch d f k ged 1940  
F b 97
- Os eo fib ma f k l l 1940 J 680
- O t og sa m 1941 A g 1155  
pe teal 1941 A 1156
- O teom f l l 1940 J  
680
- Osteom l t l sed t t m t 1941  
Dec 1700
- Osteopl t f p tech pe t  
g d f bra 1941 Dec  
1634
- O t y b m l l f m l ted  
f t l f t 1939 J 718
- O t m y l e h l d 1940 Oct  
1509
- f cra l a l 1940 J 680
- O teopo f cr l l 1940  
J 678 679 680
- O t med t 1941 F b 13  
m t l t m d cat  
1941 F b 19  
at 1940 A g 1114
- O l r y n g l g y m l t r y 1941 Dec  
1569
- Ovary ma 1940 Oct 1354  
1941 A g 1 01  
bl 1940 Ap 1 545
- O g t t d l  
1940 A g 1045
- h lat ppa B L B 1940  
A g 1150 1155 1158
- th p 1940 A g 1107 1146  
l l e 1940 A g 1110  
1116  
ph f b 1939  
A p r l 552  
h g 1940 A g  
966  
d hock 1941 Dec  
1680
- O y g h l m h p y 1940 A g  
1107 1141 1146
- P b d m t d ca dia  
l 1940 J 7 3  
diag f b d m l m  
g 1940 J 730 731  
b k l w 1939 F b 3 A g 943  
t pa t 1939 O  
1 53  
d 1940 J 805  
806

P ry t t d se se 1940  
 Oct 1371  
 t t bl l h l j t f  
 1939 D 1569  
 l f t l f h k 1941  
 D 1668  
 bl ca 1940 Ap 1  
 538  
 sciat 1939 Ap 1 475 A g 943  
 t ert b l d k l d  
 1939 F b 43  
 P l t l ft 1940 Ap 1 593  
 m ed t m d oca m f  
 1941 A g 1022  
 P l m h m g ma f 1939 F b 237  
 P l p b l f d g hyp  
 th y d m 1941 Oct 1318  
 P t g l th d 1939 F b  
 133  
 P t t m 1941 A g 1085  
 P ca m 1939 A g 888  
 th bl d t b t t 1939  
 Oct 1270  
 T t t f t m h m l g  
 ca 1941 J 719  
 P t t t 1940 J 747  
 h m h g 1940 Oct 1299  
 p 1939 O t 1253  
 sociat d th c llblad d se  
 1940 J 796  
 P pl d d l en m f 1941  
 A g 1117  
 P pl m f bl dd 1940 Ap 1 412  
 g d 1940 F b 66  
 f l t 1941 l b 69  
 f rv 1939 D 1476  
 f l y 1940 J 711  
 P t f ea l m 1941 l b  
 14  
 P ff h t hl j 1940  
 O t 1440  
 l ff ma f l g d th h 1939  
 Ap 1 462  
 P g g f 1941 A g 1164  
 l ly B ll 1940 J 686  
 f al g cal l 1940 J  
 685  
 gl t l 1940 A g 1 493  
 g f l p j 98 pl t  
 f f 1939 F l 98  
 l f l j j c  
 1941 A g 1 472  
 f l P J l  
 f l per  
 1939 A g 1 4  
 f (ua l p 1 39 l l  
 93  
 p l l l k 1939  
 l l l l J l b 161 A g 1  
 3 7 407 415

P sal ca 1941  
 A g 1011 1021  
 P th y d t t f t l  
 t t bl d g 1941 Oct 1443  
 t t y 1940 A 950 1941 O t  
 1298  
 P t b l lcoh l ject 1939  
 D 1575  
 P t l dm t t f fl d  
 1940 J 883 892  
 P l f m l g d 1940  
 J 677  
 P y hua 1940 O t 1458 1459  
 oe tg t tm t 1941 F b 239  
 P t ll d locat c t t d  
 t pla t t f 1939 F b  
 95  
 f t 1939 D 1454 1940  
 D 1771  
 P l bsc sc d ff tual J g  
 d t tm t 1941 F b 93  
 f ll g pp d t 1939  
 Ap 1 425  
 ff mm y d se t  
 bl d g 1939 F b 158  
 P t 1941 P l m y mbol m  
 f 1941 Ap 1 403  
 tl t g y f 1940 J 823  
 P l f mal ca m f  
 bl 1940 Ap 1 545  
 m 1940 O t 1381  
 p t f t l p l j  
 1939 F b 131  
 P block thesia 1941 F b  
 291  
 h d 1941 D e 1659  
 p th t m 1940 Ap 1 416  
 l t l 1941 D e 1659  
 P th l sod m f  
 thesia 1941 Dec 1554  
 P pt l 1941 J 671 679  
 bl ed g 1940 F b 207 J  
 744 1941 J 721 729  
 Dec 1619  
 mpl cat 1941 J 674  
 d 1940 A g 1212  
 d ff t l diag 1940 O t  
 1288 1941 J 669 694  
 m l y f 1941 Dec  
 1619  
 b t t y mpt m p  
 l b t ct mpo t f  
 medical ma g m 1941  
 Oct 1495  
 f scoph g l m l g  
 1941 J 727  
 p f rated 1940 J 746 757  
 1941 J 674 Dec 16 0  
 p bl m f 1941 J 665  
 l t l g t ect m f 1939  
 J 607 1941 J 682

## 1842 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

- P pt l m C d fics ex  
d 1940 F b 234  
P rf ra f bladd 1941 Dec  
1649  
f pept l 1940 J 746 757  
1941 J 674 Dec 1620  
P ia th t f h k h perthy  
d m d 1941 Oct 1235  
t m 1940 J 849  
l l p tect m 1940 Ap l  
351 361  
P ph h c 1940 Ap l 309  
1941 D 1645  
P ph t 1940 Ap l 307  
P ral fib ma f t m h 1941  
J 715  
Per os l eog sa ma 1941  
A g 1156  
P ph l ry black g l  
ralg 1940 J 663  
J 1941 Ap l 469  
g l pa 1941 Ap l 473  
P ur l t aat f p 1941  
Dec 1643 1645  
fl mma 1940 Ap l 307  
P t l bacece f l g ppe  
d 1939 Ap l 423  
p t d f p  
pe d 1939 Ap l 287  
P t oac p 1940 Dec 1849  
l ra ma 1941 Ap l  
419 423  
P d ff re tual diag  
1940 Oct 1284  
d ff se f l g ppe d  
1939 Ap l 393  
p t t th 1939  
Ap l 397  
se t h l t l  
193 Ap l 401  
lf lam d 1939 Dec 1457  
l co l t pe t l  
se 1941 Ap l 57  
P ll baces 1940 Ap l 557  
1941 F b 29  
P thral baces 1939 A g 10 5  
1941 Dec 1658  
g heal 1939 F b 19  
P t t p p 1939  
A g 957  
P so l y p ed po ur bl  
l 1939 Oct 1142  
P ca 1939 F b 91  
P sa g l 1941 F b 10  
Ph ged l tpe 1941 Dec  
1660  
Ph l g fract es 1939 D 145  
1940 D 1711  
pp t cell l 1940 Oc  
1464  
Ph m t N 1941 Dec 1533
- Ih ryng l t t ph u  
born 1939 Ap l 553  
Ph ry g ma lla baces 1940  
Ap l 563  
Ph rym ca ma 1941 A g 10 7  
Ih l j t f l h  
h d 1939 J 676  
Ph l lf ph h l tes f k d  
f 1940 Oc 136  
Pheoch moey m 1941 A 1164  
Ihl bo my 1940 A g 109  
Phl gm f l d p f ted  
d rt l m 1939 F b 210  
sodj 1941 F b 6  
Ih t fl rgr ph m l  
g ry 1941 F b 1791  
Ih t ph bu h rod d se se 1941  
Oc 1318  
Ph A g 960 rrupt 1940  
p lm y t be l  
1940 Oc 148  
Ih th p fl tfoo 1939 F l  
33  
fra t f m 1939  
Dec 144  
P h d m l 1939 Ap l 459  
h gh f q y 1939  
Dec 1553  
eed 1940 F b 121 13  
P tes See fl m hold  
l l d l 1939 A 10 6  
1939 J 699  
l l f r l se 1941 Dec  
19  
l l f f l d 1940  
A 1113  
P l m 1941 A g 908  
l m ppe d d 1940  
Oct 14  
l r d 1940 J 654  
6 9 1941 J 909  
gl d m 1941 A b 997  
g d p t f l  
bl d g 1941 Oc 1419  
Pl b rs 1941 Ap l 510  
Il m blood d hock 1941  
D 1676  
Il ba d g m k g 1941 F b  
200  
h 1941 F b 20  
Il p l p e f  
d ec 1940 J 834  
l 1941 Dec 1583  
f h d l 39 F b 27  
f h d d f 1941 F b  
37  
Pl t m scl f h b l d loc  
f h l 1939 F l 63  
P mo-e ph l g ph 1941 A g  
981

P m t my d	1941	P t p t	t l
D 1601 1604		g y 1940 A g 1080	
f m f l e 1941 A		bl t t l 1940	
1095		A g 1012	
l m p t 1941 J		g t g y 1940 A g	
82		993 1941 J 779 785	
pe t pe 1940 A g 973		hyp thy d m 1940 Ap l	
1941 J 822		525 A g 946	
g h py 1940 A g 1136		m l t d e f l	
p t thy d t my 1941 O t		1940 A k 1044	
1303		t g y 1940 A g 1054	
tg th py 1940 J 872		k g ft g 1940 A g 1089	
l m ly t l p lm y		th p t 1940	
t l l 1940 Oct 1491		A g 963	
l m pe t p lm y t		t th l p t t t my	
b l 1940 O t 1494		1940 A k 1070	
l m th t f l h t		ymp m 1940 A g 905	
d 1941 D 1597		y t 1940 Ap l 491	
d t l 1940 A g 959		d t 1940 A g 121 t	
t pl l p l r t l		h f ll g bd m l pe	
low 1940 O t 1498		t 1939 Ap l 372 449	
t 1940 O t 1476 1478		l g c mpl t 1939	
1941 Ap l 376 D 1596		A k 955	
l m t l k phy 1941 A g		yg th py 1940 A g	
982		1130	
l l my l ft f t g y		sed t 1940 A g 911	
l 1939 f l 115		P t m h gh t k Al	
l k l g h g l 1939 l l		y d m 1940 J 723	
71		P t f t 1940 D 1800	
sel l l f f t lt		m l t l 1939 J 715 718	
1939 F b 107		P th tech f m l l l	
l l h 1939 F l 155		l l 1939 Oct 1290	
l l p g cy 1940 l l		t eca l gest 1940	
256 263		F l 117	
l l p c ry l 1939 F l 158		f 1939 Dec 1465	
D 1475		f k d m m mb	
g l l l g f m 1941		h gl f eq t	
867		1939 D 1552	
f l 1939 l l 207 1940 Oct		P g y b h p a t t d	
1344 1941 J 845		1939 f l 249 254	
g t l 1939 Oc 1135		mpt t ar l bl d g	
g l g 1939 Oct		1941 J 867	
1090		t l m t d d	
l y l l l t t		f 1940 l l 259	
1941 J 850		l l d g 1939 l l 160	
l l 1940 J 710		1940 f l 249 259	
l h l l 1941 J		t l 1941	
718		P r g l l	
l rth g 1941 J 725		P j hall 1939 F l 26	
l c f p l esth 1940		l pe ca ct l	
639 1941 l c 1548		g bl a t t l c e 1940	
l ph l 1940 J 677		A g t005	
l l c l l t co g l		h pe hy d 1940 Ap l	
l l c f l p 1939 F b 8		523 A g 941	
l m 1940 J 22		g t g y 1940 A g	
h ck 1941 l c 16 j		980 1941 Oct 1465	
l d mp l l j A g 1042		l d e e f l	
l l 1940 Ap t 3 5		1940 A k 1033	
l h l c c y 1940		l ry 1940 A g 1049	
k t247		k g f g 1940 A k 1097	

- P coprat ca th gery  
 1940 A g 953  
 t th l p ost t ct my  
 1940 A g 1061  
 ympos m 1940 A g 90  
 d t 1940 A g 1211  
 l cat 1940 J 621 A g  
 907  
 p pa t f k 1940 A g 931  
 P p h m 1940  
 Ap l 379  
 P l t my f p  
 m y d m h 1941 J  
 855  
 P he t t l f 1939  
 Dec 1466  
 P c f local d eg l es  
 thes 1941 F b 278 D 1551  
 f p l th m 1941 D  
 1547  
 t 1941 F b 29  
 Proc gm d p 1940 Oct 1320  
 P g t f ct l  
 bl l g 1941 O l 1450 14 1  
 l l p e f d t m 1940  
 J 829  
 f l g l l l 1940 J  
 710  
 l l p lpo 1940 Oct  
 1431  
 f t 1940 J 826  
 pessary t tm t 1941 F b  
 115  
 g l h t ec my f 1939  
 J 803  
 P t bscen 1941 Dec 1656  
 g rth l 1939 F b 19  
 m 1939 J 783 1940  
 Ap l 358 414 1941 A g  
 1181 D 1655  
 ged 1940 F b 64  
 bl 1940 Ap l 545  
 d cal p f 1939 J  
 783 790  
 d se d f tualdiag 1940  
 Oct 1371  
 mbry l gy 1940 Ap l 354  
 h p ph 1940 F b 10 Ap l  
 351 1941 D 1652  
 y t scop 1941 F b 13  
 m sag 1940 Ap l 374  
 l be gn 1940 F b 59  
 sa ma 1940 Ap l 358  
 t b l 1940 Ap l 359  
 P t t t my 1940 F b 61 Ap l  
 351 361  
 hesal 1940 Ap l 435 436  
 pe l 1940 Ap l 351 361  
 l f f ca ma 1939 J  
 783 90
- P t tect my p p b 1940  
 Ap l 351 361  
 t h f p t t l t  
 1941 D 1653  
 t thral 1939 F b 177 J  
 765 1940 F b 60 6 65  
 Ap l 31 361 A g 1061  
 1941 Dec 1653  
 sat f t y lt ca se d  
 co t 1941 O t 1371  
 P t t t h 1940 Ap l 367  
 P t t t my 1939 F b 197  
 P t to- l t 1941 F t 123  
 l t t fbl d pl m  
 1939 Dec 1590 1591  
 P th mb d f ex m k  
 p d po t pe se 1940  
 A g 1203  
 l l f blood pl m 1939 Dec  
 1593  
 m hod f m g 1939 A g  
 893  
 P l h t ject l  
 1939 J 689  
 l ged 1940 F b 110  
 P se d p l jnd m 1941  
 Ap l 419 423  
 P y h t ma l l 1939 D  
 149  
 P y h se h pe th d m d 1941  
 Oct 1228  
 po pe t 1939 A g 963  
 P rjg m 1941 F b 5  
 l t rjg ph y g l l se 1940  
 Ap l 561  
 P b rty p ec  
 m 1941 A g 1206 1207  
 f d l g 1941 A g 1167  
 P rpe m p l m mb l m  
 1941 Ap l 405  
 f lm y Se l L  
 mbol m l fl r ma d  
 g y l m d  
 pel 1941 Ap l 383 390  
 394 396  
 P p p t 1941 J 823  
 h p A g 1940  
 April 353  
 P t d d 1939 D 1355  
 f h d 1941 Ap l 435  
 P p th mb t pe 1940  
 Oct 1569  
 bl ed g 1939 F b 154  
 P m pe f M  
 y d m 1940 J 2  
 l tt p t f lca 193  
 F b 135  
 l y lograph m f k l  
 ged 1940 F b 71  
 g d l j ry 1941  
 Ap l 449

- lyl lth t my 1939 Oct 1285 1289  
 Py l ph t 1940 Ap l 308  
 Py l pl ty 1940 Ap l 295  
 Pyél t m él g 1939 Oct 1288  
 lyl phl b t m p l e a t g p p d  
 t 1939 Ap l 443  
 lyl b t g t l 1939  
 Dec 1557 1940 Oct 1503  
 Ramm t d t p e r t f  
 1939 D 1558 1563  
 m d e a l m g m t 1941 J  
 735  
 b t t y m p t m  
 p p t l m p o t f  
 m d l m g m t 1941  
 Oct 1495  
 Pyl pl ty f p p t l e e 1941  
 J 680  
 lyl p t p p t p p  
 t 1941 O t 1465  
 Pyod m f 1939 A g 1029  
 f y d 1941 J 791  
 Py a p t t f l g l  
 th l p t t e c t m y 1941 O t  
 1381  
 Q r t e o p l y t b  
 l t p l t t f 1939 f b  
 93  
 Q k m h d f d t m g p  
 th b l t t g t m 1939 O t  
 1265  
 Q d l f t h y p e r t h d m  
 1941 Oct 1369  
 I 1940 f b 122  
 R d l r t l t p t f  
 1939 Dec 1452  
 Rad m t m t f c a m f  
 1939 J 813 815  
 1941 A g 1195 1197  
 f p 1939 O c 1327  
 f f l b l e e d g  
 1941 Oct 1449  
 f m l g d e e l  
 1941 O t 1488 1490  
 f k 1940 l b 128  
 f p h n g f a l g e s  
 1940 f b 160  
 l l f p p d 1939  
 D 1445 1940 Dec 1657  
 l d 1940 Dec 168  
 h f 1940 Dec 1669  
 h l t m 1939 O c 1311  
 h d l k d l o c a t  
 1940 J 845  
 Ra d p 1939 O c  
 1558 1563  
 l e c l e s h u a f h r o a d r g r y  
 1941 Oct 1266  
 R t l p h t g c 1940  
 O t 1376  
 Rect g m d c a m 1941 A g  
 1129  
 g d 1940 f b 26  
 R t g l f i t l 1939 A g  
 1024  
 R t m c a m a S e e C m f  
 f  
 d g t l m t m  
 1941 A g 1130  
 l m t 1940 J 807  
 p e t h f t h t  
 1940 J 644 Aug 927  
 p A g 1077  
 p t p e c 1940 J 829  
 t t b e g d t d t  
 1939 O c 1185  
 g c a l l t h m y f 1940 O t  
 1352  
 R t f p p d t m y  
 1939 Ap l 368 449  
 Rec t l y g l r y t  
 d t m y 1941 O t 1295  
 R g l t h N l p t  
 1941 D 1551  
 f p t k 1939  
 J 583  
 p l m m o d c a t 1940  
 J 628  
 l t 1939 O 1171 1172 1175  
 1180 1940 J 740  
 Reg g p p e d 1939  
 Ap l 329  
 R m p l t t l t t b l d  
 d 1940 Ap l 341  
 R l S e A d y  
 R s e c f k d y 1940 Ap l 290  
 1941 Dec 1644  
 R e t p l l d d t m  
 g d 1940 f b 68  
 m u C p b e l l 1940 Ap l  
 387  
 R p t t f i a l b e  
 1939 Ap l 551 552  
 R p r a p l l m d g p l  
 t h u 1940 J 635  
 Resp y c o p l e a t f h  
 d e c t m 1940 Ap l 528  
 A g 249  
 f e t b d m l p e t  
 p s e f 1940 A g 9 6  
 h e e f e s h e g t  
 1940 A g 9 8  
 Res l e s p l t h u 1940  
 J 637  
 Res e t f b o r n 1939 Apr l  
 547  
 Res e t L d J 1939 Ap l  
 554

- R t sepa t 1941 Ap l 335  
338 339  
R t od pl m t f er pessa  
t m t 1941 F b 10  
R ph yng l b-c 1941 F b  
30  
Rh h 1941 F b 24  
Rh ph ma 1939 Ap l 461 1941  
F l 21 46  
Raboff 1941 J 91  
p r c 1940 F b 5  
R b f t es 1940 Oct 1477  
Dc 16 8 1941 Ap l 37  
Dc 1508  
t pp 1940 Oc 1474 1475  
1941 F b 197  
R g d ty g er lized post perat  
1939 A g 961  
R u se t rnb kl scol  
1939 F b 143  
Rox g diag f c ma f  
m 1941 J 841  
f l g 1941 A g 1087  
f ma h 1941 A g 1104  
f l d cases 1939 Oct  
1071 1086 1940 Oc 13 1  
1535  
f d se f g M l dd d  
f lya y t et 1939 A g 913  
f pept f 1941 J 668  
f pol p f et 1941 J 850  
f th ra d seac 1940 A g  
936  
f b l b 1941  
J 829  
exam t f t 1939  
Dec 1439 1941 Dec 1789  
f k d y p t g bl  
1939 A g 1041  
f tra ma ed bd m 1939  
Dec 1427  
ray ml y g ry 1941  
Dec 1783  
p tte f p so l 1941  
Dec 1787  
t m 1940 J 869 1941  
J 913  
be gn et f es d  
t 1939 Oct 1185  
mlt y k y 1941 D  
l 91  
f m f r 1939  
J 813 815 Oc 1328  
f l yn 1941 A g 1034  
f k 1940 F b 128  
f f l t bleed g  
1941 Oct 1449  
f g t l t m l d  
1939 Oct 1313  
f fec ed d 1939 Dc  
1365
- Roe tg t m t f mal gn t d a-  
se luat 1941  
Oct 1490  
preope d ca so d  
l m t 1941 Oct  
1488  
f g cal l 1941  
F b 233  
f soph y eal mal k c-  
1940 F b 160  
p eoper t thy l l e e  
1941 Oct 1305  
Roe tg g m l t l fra  
f f m f ck 1939 A g 9 8  
R g A d so t m cal pl  
1941 F b 225  
R pt f bladder 1941 Dc 1649  
f d m b bomb bla 1941  
D 1576  
f l p l p m 1939 Ap l  
4 6 1940 Oc 1417 1422 14 8  
1431  
f pl e t ma 1941 Ap l  
45  
h d l yed h m rrh g  
1940 F b 19  
f hra 1941 Dec 1658  
R self traction f f m l  
h f 1940 Dec 1746  
t och r fra t e  
1940 Dc 1735  
R b M l tra so in fract es f  
ech f f m 1 39 A g 9 7
- S RAL block h 1941 F b  
293  
Sacro-lu l ha l pa 193  
F b 36  
t ght h 1940 Oct  
1429  
Safp g t ba f 1940 Ap d  
449  
S l b f m b f d  
f pera 1940 A g 1195  
S l l e p 1940  
Ap d 4 0  
Saph l ga 1939 Dec  
1533 1540  
S a ma f b 1941 A 1153  
f cum 1940 O 1326  
f j 1941 A 10 0  
f k d y 1941 A 1177  
f ph 1940 F b 155  
f arj 1941 A 1 09  
f p 1940 Ap l 358  
f h d gl d 1941 A g 1048  
b 1941 A g 1153  
pe l 1941 A g 1156  
Safp ca m 1941 A g 974  
f ld block 1941 F b 83

- Scalp l t 1941 Ap l 522  
hld 1941 Ap l 325  
Scaph l y 1939 F b 26  
f ct 1939 Dec 1451 1940  
D 1695  
l f mbl g f  
t 1941 Ap l 499  
Scap l f t 1940 D 1626  
Sca p eca ged 1940  
F l 123  
oe tg t tm t 1941 F b 240  
Sch l t t 1939 D 1467  
Schm k t m 1940 F b 154  
Schm l d se 1939 Ap l 475  
Sch ll Ch tia d se f al  
lt 1940 J 680  
Sch rt t t f 1939  
Dec 1535  
Se t er l h l j t 1939  
D 1575  
S tea 1939 F h 35 Ap l 475  
A g 943  
f m h t f t i b l  
d k 1941 J 889  
unt rv rt b l d k l d  
1939 F b 43  
Se l 1939 F b 137  
S bo h k t 1940 F b 118  
Sed t hyp thy d m 1941  
Oct 1262  
d g 1940 A g 908 909  
p t p c t 1940 A g 911  
P eope t se 1940 J 6 2  
A g 907  
Sem ly 1940 Ap l 483  
Sem l ca t l g f pl m  
1940 Oct 145  
m l 1939 J 709  
Se l l d g t l m  
1939 Ap l 317  
lt 1939 Ap l 317  
g h l 1939 F l 198  
S g t 1941 J 64  
S pt m ph l h l  
l 1940 O 1510  
Sept m sal l 1941 l b  
26  
d llec 1941 l l 26  
Se m blood l h ck 1941  
D 1676  
f m f h l  
1941 Oc 1294  
h l 1748 k 1941  
D c cal f c 1939 D c  
13 4 l l  
l 40 J s  
h l 41 A k 1169  
l l h l 40 Ap l 367
- Sh m t l t pl t t f  
h ll l f t 1939 F l 8  
Sh p h pt l 1941 D 1540  
U S N y m g m t f f  
t b d 1941 Dec 1703  
Sh t t d l 1940 O t 1466  
Sh k t ia f 1941 D 1775  
f t d d t y 1941 Ap l 528  
f m t m t d 1939 D  
1370 1940 A g 1120 1941  
D 1528 1663  
f bd m 1939 D 1429  
1433 1435  
f h t 1940 O t 1473  
f m w d 1941 D 1663  
b 1939 Dec 1501 1941  
D 1735 1736  
g t t t l g 1941  
J 795  
l j y 1941 Ap l 447 451  
th 1941 D 1595  
t d th ps 1941  
D 1769  
at f d d l 1941 D  
1772  
p t 1941 D 1671  
p t 1941 D 1663  
se d p l th  
1939 Ap l 36  
u g cal 1940 A g 1120 11 2  
l tm 1940 A g 1093 1123  
1124 1941 D 1663  
l g g 1940 Ap l  
431 436  
Sh t f h ll lg  
1941 l b 171  
Sh ld th od f t l  
p ly 1939 F b 122  
l l cat 1940 J 845 D  
1620  
h l l 1939 F b 59 1940  
D c 1625  
f ct 1940 D c 1613  
b t p w th f ll g  
1940 J 845  
j th l es 1940 Oct 1444  
p u h f hype thy l m  
l 1941 Oc 1235  
ma 1940 J 849  
S g d c m 1939 A g 1011  
Oct 1128 1941 A b 1129  
d m t 1940 J 807  
S lk f pa f l l m l h rna  
1941 J 881  
ca g t h l gerv 1940  
F b 241  
S pos t 1939 J 671  
hl 1940  
Oct 1441  
S ger odes 1939 J 819 1940  
J 05



- R t p t 1941 Ap 1 335  
338 339  
R t od pl m t f t p wa y  
t tm t 1941 F b 107  
R t ph y g l hsc 1941 I 1  
30  
Rh t h 1941 F b 24  
Rh phym 1939 Ap 1 464 1941  
F b 21 46  
R b fl 1941 J 791  
p eg 1940 F b 252  
R lra fra t 1940 Oct 1477  
Dec 1628 1941 Ap 1 3 2  
D 1598  
t pp g 1940 Oct 1474 1475  
1941 F b 197  
R h l g l d p p t  
1939 A g 961  
R c t l kl ca t c l  
1939 F b 143  
Roe g duag f f  
1941 J 841  
f l k 1941 A g 1087  
f t h 1941 A 1104  
f l d c c 1939 Oct  
1071 1086 1940 O 1321  
1535  
f d c f g ill dd J  
b la y t et 1939 A g 913  
f pep l 1941 J 668  
f poly p f c l 1941 J 850  
f th d c c 1940 A g  
956  
f t b l 1941  
J 829  
m t f t 1939  
Dec 1439 1941 D 1789  
f kud y p t g t bl  
1939 A g 1041  
f t ma ed bil m 1939  
D 1427  
y m l t y g y 1941  
Dec 1783  
p ect f pe so l 1941  
Dec 1787  
t trv t 1940 J 869 1941  
J 913  
be gn t ct f t d  
t 1939 Oct 1185  
m l t g y 1941 D  
1791  
f ca ma f rv 1939  
J 813 815 Oct 1328  
f 1941 A g 1034  
f k 1940 F b 128  
f f t al bl d g  
1941 Oct 1449  
f gua t ll t m f d  
1939 Oct 1313  
f feet l d 1939 D  
1365
- Roe tg t tm t f mal g t d s  
e luat 1941  
Oct 1400  
p p t d cat d  
l m t 1941 Oct  
1488  
f m rg cal l 1941  
F b 233  
f ph y g l m l g  
1940 F b 160  
p eop t thy d d c c  
1941 O t 1305  
Roe tg k m lat l f  
ff m l k 1939 A g 928  
R A d rsc t m cal pl  
1941 F b 225  
R pt f bl dd 1941 Dec 1649  
f d by b mb bl 1941  
D 1576  
f l p lpo 1939 Ap 1  
476 1940 Oc 1417 14 14 8  
1431  
f pl t m t 1941 Ap 1  
455  
th d l y ed h m rth g  
1940 F b 195  
f th 1941 Dec 1658  
R cell t f t f f l  
h f 1940 Dec 1746  
t och fra  
1940 Dec 1738  
R th bl ll t f f  
ck ff m 1939 A g 9 7
- S c bl k h 1941 F b  
293  
Sa ha l b k pa 1939  
F b 36  
t ght h 1940 Oct  
1429  
Salp g t t b l 1940 Ap 1  
449  
Sal bal m bef d  
ft p t 1940 A 1195  
Sa l l t pt 1940  
Ap 1 4 0  
Saph l g 1939 D  
1538 1540  
S m f b 1941 A 1153  
f 1940 Oct 1326  
f j 1941 A g 1020  
f k d 1941 A g 11 7  
f ph n 1940 F b 155  
f 1941 A g 1209  
f p 1940 Ap 1 358  
f hy d gl d 1941 A g 1048  
t o 1941 A g 1153  
p l 1941 A g 1156  
scalp m 1941 A g 9 4  
f ld block 1941 F b 283

Scalp l t 1941 Ap l 522	Sh m t d l pl t t f
h ld 1941 Ap l 325	h ll w l f t 1939 F b 82
Scaph d y 1939 F b 26	Sh p h p t l 1941 D 1540
fra t es 1939 D 1451 1940	U S N y m g m t f f
D 1695	t b d 1941 Dec 1703
l f mbl g f	Sh t t d b 1940 O t 1466
t 1941 Ap l 499	Sh k t f 1941 D 1775
Scap l f t 1940 Dec 16 6	Sh f t d l l y 1941 Ap l 528
Sca p ca g d 1940	f m t m t w d 1939 D
F b 123	1370 1940 A g 1120 1941
tg t tm t 1941 F b 240	D 15 8 1663
Sch ll t t 1939 D 1467	f b l m 1939 D 14 9
S hm k t m 1940 F b 154	1433 1435
Schm l d se 1939 Ap l 475	f h t 1940 O t 1473
sch ll Ch t d se f l	f m w w d 1941 D 1663
lt 1940 J 680	b 1939 D 1501 1941
Sch rt t t f v 1939	D 1735 1736
D 1535	g t t t l g y 1941
Se t l h l j t 1939	J 795
D 15 5	l l 1941 Ap l 447 451
S uat ca 1939 F b 35 Ap l 475	h l d th py 1941 D 1595
A g 943	t D 1769
f m h t f t r v l b l	t f b d l 1941 D
d k 1941 J 889	177
t rt b l d k l d	p t 1941 D 1671
1939 F b 43	p t t 1941 D 1663
S l 1939 F b 137	se d y p l th
S b h k t 1940 F b 118	1939 Ap l 362
S d t hyp thy d m 1941	t g l 1940 A g 1120 1122
O t 1262	t m t 1940 A g 1093 1123
d g 1940 A g 908 909	1124 1941 D 1663
p t pe t se 1940 A g 911	l g g y 1940 Ap l
p p t 1940 J 622	431 436
A g 907	Sh t f h ll v lg
S m l 1940 Ap l 483	1941 F b 171
Sem l t l g d pl m	Sh ld th d f l
1940 O 1452	pa ly 1939 F b 12
m l f 30 j 709	d l ca 1940 J 845 D
S m l d l cam t	16 0
1939 Ap l 317	h h l 1939 F b 59 1940
l 1939 Ap l 317	Dec 1625
l h l 1939 F b 198	f t 1940 Dec 1613
S g t t m 1941 J 764 l l	b t p th t f ll g
S p m t ph l oc	1940 J 845
d 1940 O 1510	J th l tes 1940 O t 1444
Sept l loc 1941 F b	p th t f hyp th d m
26	d 1941 Oct 1235
l fl 1941 F t 26	t m 1940 J 849
S m bl d d h ck 1941	Sgm d ca ma 1939 A g 1011
D 1676	d 1128 1941 A g 1129
f m f hy l	d 1940 J 807
1941 Oc 12 4	S lk f pa f bd m l h rma
h p g 1941	1941 J 881
D 1748	ca g hy d g y 1940
cal f 1939 Dec	F b 241
13 4	S po t 1939 J 671
h l k l pa	a thl j es 1940
1 40 J 685	Oct 1441
l 1941 A 1169	g les 1939 J 819 1940
l 1 40 Ap l 36	J 705

## 1848 INDEX TO VOLUMES 19 '90 AND 21 (1939-1941)

- S ses l 1939 A g 1021  
pa sal care ma f 1941 A g  
1011 10 1  
J 1941 Dec 1573  
p l id l 1939 J 699  
po t ph ec m t bere l  
1940 Ap l 400  
S 1941 t b 27 28  
ma ll ry tra asal t t m  
1939 Oct 1243  
Sk l t l t ct 1941 F b 222  
tra t l f m l h l  
1940 Dec 1750  
Ski ab d la  
h ld 1941 Ap l 536  
l in p ples t t tm  
1941 Ap l 55  
t h t u l t f  
t ry 1941 Ap l 537  
d seases oc g h p 1940  
J 80  
gr ft f h d 1939 F b 28  
ped f f les f f e d  
eck 1941 F b 41  
p d pos pe t ca 1940  
A b 1057  
mal g f h gh f eq y  
1939 Dec 154  
g d 1940 F b 124 128  
p eca or les h gh f eq cy  
1939 Dec 155  
pr pa t t pe 1939  
Dec 13 8 13 9 1940 A g 931  
tract 1941 t b 220  
ber l ged 1940 F b  
123  
Sk ll d ses flec g 1940 J  
675  
fract et 193 Dec 1411  
hul 1941 Ap l 325  
x tg m 1941 Dec  
1780  
Sm g l 1941 J 93  
Sm h P t l fract l  
eck f f m 1939 A g 929 933  
937 939 Oct 1 35 1940 F t  
8  
Sod m hl d m bel m 1940  
J 886  
pa ral d 1940  
J 89  
un d hock 1939 Dec  
1372 1941 l ex 1673  
164  
p eo pe se g  
tes l g ry 1941 Oc  
1466  
l m nat eg m M  
ynd m 1940 J 73  
pe t th l esthesia p l m ry  
med ca von 1940 J 68
- Soft t un es fan d h l  
d 1941 Ap l 535  
homogy sa h oc m thod f  
mylase 1940 Oc 1247  
So t ppa 1941 F b 218  
d ficult fract es f b th b  
f f m 1941 Apr l 580  
Spa h C l W l sed pla ter  
t catm t 1941 Dec 1698  
Speech g l f pal case  
1940 Apr l 600  
Speed per t l h b ual d loca  
t l h lder 1939 F b 64  
Spe m t oa dy f 1940 Ap l  
483 1941 J 918  
Spe c d 1941 Dec  
1660  
Sph oc os co t l 1941 Oc  
1455  
Sphun t ectal g 1940  
Oct 13 5  
Sp l ccessory f al ry o  
m 1940 J 692  
hesia 1939 Ap l 353  
g t 1941 Dec 154  
mpl cat 1941 Dec 153  
m g es t tm l 1939  
Ap l 353  
phed m th 1939 A g 10 5  
1941 Dec 1548  
f l ptra 1939 D  
1514  
f g t g ry 1941 J  
685 804  
f ct nal 1941  
J 808 Dec 13 0  
mpo ce l ed pe ed  
es h t 1940 J 613  
N al p ct ce 1941 Dec  
1546  
d ca d tra d ca  
1940 J 615  
ma g m l pa 1940  
J 631  
pe ca f 1940 J 637  
1941 J 804  
h l d g 1940  
A g 1119  
pa oca gl one sal t m for  
1940 J 639  
pe p ct h d h 1939  
J 695  
p l m m j ca 1940  
J 6 A 912 1941  
Dec 1548  
v l la 193 Ap l 363 1940  
J 631  
mpo 1940 J 611  
ech 1939 Ap l 38  
d J es 1939 Dec 1416  
1940 F l 69 1941 Ap l 433



## 1850 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

St pp g l h t 1940 Oct 1474	S lf l m l b t e 1941
1475 1941 F b 197	Ap l 577
Strap M tg m y 1939 D c 1369	S lf py l r t ept
S ptooc lect m cr er	1940 Ap l 00
ph l 1939 D 1396	g cal feet h l l
f d 1941 D c 1744	1940 Oct 1514
St t f l l d 1939 A g 86	S lf th l t ph l e cal f
f ry g l bl ed g f m	t f d 1941 Dec 146
1941 J 867	d 1941 Dec 1734
f col be m 1939 Oct 1077	S lf m d d g r y m
f m d ct 1939 A g 907	lec 1941 D c 164
f t m be l t d	S p f t m 1941 A g
t 1939 Oct 1185	1085
f th 1941 D c 1656	S p l p t tect y 1940
f ll g t thralp t t	Ap l 351 361 1941 D c 163
t m 1941 Oct 1377	S g ry m l r y y mpo m
g h l 1939 F b 199	1941 Dec 1523
h ld 1940 Ap f 381	S g cal m thod f m l y
St d mpleat g th y d )	g fca 1941 D c 152
1941 O c 1292	S pe pe f h h l
St md f perat 1939 Dec. 1472	d local f h ld 1939 F b
1474	65
Sty 1941 F b l	S l l l m l l f e 1940
ba h d l h l j et 1939	Dec 1826
D c 1576	St f r y 1941 Ap l 473
S ba t g l d d l e t 1941	p m 1941 Ap l 476
Ap l 502	seco l ry 1941 Ap l 481
S bgl tt la yn u hype t ph	S ur m t f pe
1940 J 707	d b 1939 D c 1380
S bh pat l e s f ll g ppe l	f ed d 1939 Dec 135
t 1939 Ap l 433	f p f t d pep l 1940
S bm ll y bace 1940 Ap l 56	J 763
S bph bace f ll g ppe l	f l 1939 F b 117 119
1939 Ap l 435	Ap l 499
S t tes l b t et	d heal g d 1940 Dec 1861
1940 J 78	S mbl ph m correct
S deck ph j	1940 Ap l 586
hy t 1941 Ap l 506	S mpa h et y f tal h pa
ga g pl 1939 Dec 1449	1939 A g 969 Oct
1940 l e 1691	105
S lf d d 1941	f H sch prug d e a e 1939
D 1734	Oct 1166
S lf l m d t p	S mpath bla t m 1941 A g 1163
1940 Ap l 425 500	S mpa h g ma 1941 A 1163
h l g 1939 Oc 1268	S d t l m eo g l 1939 F b
h l ra l s 1939	231
Oc 1089 109 1096	Sy oc cr 1940 J 67
y pel 1941 F b 59	Sy et my f th f k ce
lymph g f h d 1940	1941 J 893
Oc 1465	Syph l f b 1941 F b 6
dia 1941 F b 14	f l g d b 1940
pe 1939 D 1457	O 1550
t p oc cal fec f l	bl ed g 1939 F b 154
1941 Dec 1745	S ph l com l f ra l
in g cal f 193 D	l 1940 J 680
1386	
h ld 1940 Oc 1513	
d 1941 Dec 1733	
1741 1744	T 1941 D c 163
t p l e 1941 Ap l 577	T be na m bla y
t 1939 D c 1462	g 1939 A g 860 1940
	A 1016 Dec 1839

T l p e t d t p l t t f	Th oat p e t h f
1930 F b 83 87 91 Ap 1 496	th t 1940 A g 924
497	1 r 1941 D 1574
q l g p t f 1939	Th ml t p p r p 1940
t l 135	O t 1569
q p l y t 1939 F t 134	t b l d g 1939 F t
T p e l c a d 1941 Ap 1 375	154
T d b 1939 D 150	Th mb p h l b t f p p e d l r
T m t t s a l f t d l t	g 1939 Ap 1 443
1941 Ap 1 r 0	Th l t t g l 1940
T l g t t y 1941 J 764	l b s
85	l t m t y l
T th f n e d s e 1941	p e l f l l g t m d
l 1803	g y 1941 Ap 1 383
T m p o l b e f t 1941 Ap 1	Th ml h k p t St ll
363	1939 F l 129
T d f l t l p l	l l t 1940 D 1719 1720
y 1939 F b 116	h p l t y 1939 F b 127
l g t h g 1939 F b 118	Thy l r t y f t p l a
f h d s e c o l y p a 1939	l g t t h 1941 O t
F t 242	127
h t g 1939 l b 118	p t t h f t h
t 1939 l b 117 119 Ap 1	d g y 1941 O t 1275
499	1940 Ap 1 527 A g 945
t p l t t f t h d	1941 O t 1306 1309
p l y 1939 F b 128	g l l d m 1941 O t 1334
f t l p a l y 1939 F b	f e e b l k e a 1941 O t
116	1333
l t t y 1939 F l	h h 1941 O t 1313
79 Apr 1 493	h p e r t h y l m 1941 Oct
T l l w 1940 O t 1445	1331
T t t p p t	m l t l 1941 A g
1940 O t 1467	1017
T t f y 1941 A h 1209	g th f 1941
T t j 1941 D 1660	Oct 1265
t t l t m 1940 Ap 1 415	c a t e t l k 1940 F b
t b l 1940 Ap 1 403	241
T t t p p t l	m p e t f f t h y l
l l e c l g 1941 O t 1448	t 1941 O t 1275
T t p l t t	g e d 1940 F b 39
1937 l h 1357 1394	l e a t f t l t
1745	l t l g 1941 Oct 1447
T p h l 1940 A h 950	c t p o p e t l 41 Oct
1941 O t 1 98	1306
Th t f O p e 1941	Thy l t th a f 1941
l e e 1688	O t 1205
l l e l l t l 1941	l l e c k t h f 1941 F l 284
A g 1207	m p l r a t 1940 Ap 1 527
l h l f e 1940 Oct	1941 Oct 1291
1467	t e h l p e t l
l h 1941 J 91	1941 Oc 1269
l k 1941 l l 25	l d k e a s e 1941 Oc 1303
l l p l t 193 Dec 1438 1941	m l m l l g 1940 Oct
l l 2 3	1303
h l l e a 1941 Dec	p l p e r a t e c a 1940
l b o	Ap 1 523 A h 941
l h r s e l c h t	e e l h f 1939 J
l t s e 1941 Apr 1 3 9	583
h th ph t h t	s e e d l r e t p e
h m 1941 Oct 1383	h p e r t h r l m 1939 J
	573

- Thyr d t m ht tal 1939 J  
565  
thy I h rt d se se 1940  
O t 1306  
t h m p l y g t cap f  
l g f f thy d rt y  
1941 Oct 1275  
t t y ft 1940 A g 950 1941  
O t 1298  
se f od 1941 O t 1255  
f y g f 1940 A g 1137  
Thy t m f ca m f l y  
1941 A g 1031  
Thy t rg ry f fl f  
g t lkal d 1940 Ap t 567  
Tba fract l d t  
t p 1941 April 503  
h ft 1939 Dec 1455 1940  
Dec 1781 194  
w h 6b la 1939 Dec 1455  
1940 D 1 82  
p 1940 O t 1454 Dec 17 8  
t be out 1940 Dec 1776  
t be l partial sepa t 1940  
Oct 1454  
T d l bd m l 1939  
Oct 1298  
l h l jec 1939 D c  
1570  
T bl k esth ia 1941 F b 292  
t ed 1941 F b 169  
f ct 1940 Dec 1835  
h mm 1941 F b 169  
jur f t d d t y 1941  
Ap l 524  
T g ca m 1940 F b 127  
1941 A g 1023  
T ll t my m l c y f 1941  
Dec 1569  
d cat 1941 F b 32  
p pe t sed t 1940 A g  
910  
t h d lt 1941 F b 33  
h ld 1941 F b 33  
d local h 1939 J  
825  
T ll t d t pp d  
t 1940 Oct 1269  
hyperthy dsm ma k d by 1941  
Oct 1238  
T l mal gn t t m rs 1941  
A g 1029  
Tooth d f kn kl 1941  
Ap l 488  
T f perma rd 1941 Dec  
1660  
T q t 1941 Dec. 1667 1764  
T ma b 1939 Dec 150  
1941 Dec 1735 1736  
f t tinal b t ct 1940  
J 786
- T mia f p g cy t  
1940 F b 256 261  
T h j m p l cat g thy  
d t my 1941 Oct 1292  
T h l fl t phy ia  
bo 1939 Ap l 553  
T h l pl ty 1939 D 1472 1474  
T h l h phy 1939 Dec 1472  
T h t mv m g y 1941 F b  
35 56  
mp d p oc d f 1939 J  
579  
T 1941 F b 217  
mp l 1941 Dec 1765  
meeh cal f ct f both  
bo f f m 1941 Ap l 584  
T f 1940 J 875 A g  
1094  
J hock 1939 D c 137  
1941 D 1674  
T po t t f t f m  
es 1939 D c 1437  
p l d y y 1941 Ap l  
439  
f se ly j d 1939 D c  
1434  
f J ed 1941 D c 1767  
T h l p t t sect  
1939 F b 177 J 765  
1940 F b 60 62 65 Ap l  
351 361 1941 D 1653  
p d po t p rat ca  
1940 A g 1061  
sat f t y lt ca a  
d ct 1941 Oct  
1371  
T m Se I J  
T m t f t l l 1941 Ap l  
543  
h ia 1941 Ap l 5 8  
g y ym po 1941 Ap l  
311  
d 1939 D 1345  
f p t d  
m 1941 D 1730  
1739  
hock d h h g 1939  
D 1370 1940 A 1120  
1941 D 1528 1663  
T d l b g f n  
1939 J 1536  
T a g l b d g 1941 Dec  
1752 1762  
T g m l r y l h l j  
f bl p 1939 D c  
15 0  
ralg 1940 J 663  
T bal tflat l 1939  
Ap l 542  
p gn y bleed g 1939 F b  
160





- U1 diathes 1941 J 665 666  
 d x d l Se l-o P pt l er  
 g j l l 1940 J 767  
 j j l 1941 J 743  
 j j l 1941 J 6 6 722 743  
 f f l m b rn 1941 F l  
 44  
 f leg h k g f g  
 1940 A g 1089  
 mod fed ka d leo perat  
 f 1941 Ap l 617  
 p p t See P pt l er  
 Ulee t col See C l ul er  
 l  
 U1 fract es 1940 Dec 167  
 p p e d 1940 Dec 16 6  
 U1 post pera 1939  
 A g 9 6  
 l 1940 Oc 1284  
 U padded ca f fract f h d  
 d fi ger 1940 Dec 1695  
 U berra es-el 1940 Ap l  
 324  
 mal es 1940 Ap l 3 3  
 cal l 1939 Oct 1275 1940  
 Ap l 33  
 c p d p l g ph  
 1941 F b 145  
 ma p la 1941 F b 153  
 f lea g 1941  
 F b 156  
 cath 12a so abl k l  
 1941 F b 140  
 d l g l 1940 Ap l  
 327  
 d e se d ff l diagnosis 1940  
 Oc 1300 1357  
 hernia cal 1940 Ap l  
 328  
 j er 1940 Ap l 335 1941  
 Dec 1649  
 h y ec m 1940 Ap l 443  
 b et r fec  
 1940 Ap l 442  
 postea l 1940 Ap l 3  
 mpla ta blaid 1940  
 Ap l 341  
 1940 Ap l 334  
 rg ry f 1940 Ap l 328  
 urg cal d so ders 1941 Ap l 323  
 tra pl ect r g m l  
 f ext ph l bl dd  
 f t 1941 Oc 1399  
 t m 1940 April 337 412  
 t t ect my 1940 Ap l 331  
 L o-bd m l fi la p m h  
 t ect m 1940 Ap l 445  
 U et ocel 1940 April 3 3  
 L l 1940 Apr l 330  
 L os m es d ca  
 f 1941 J 877
- L t t my 1940 Ap l 331  
 U t g l fi l l 1940 Ap l  
 336  
 posth ec my 1940 Ap l  
 445  
 L th cath mal 1940  
 A 1062  
 l p l l b t  
 g l 1940 Ap l 383  
 l l t 1941 D-c 1656  
 h p t 1940 Ap l  
 371  
 l case d ff tual iug on 1940  
 Oct 1371  
 p t 1941 D-c  
 1658  
 1941 D-c 1636  
 f ll g hral pr ec  
 y 1941 Oct 1377  
 g rrrh al 1939 t l 199  
 h l l 1940 Ap l 381  
 t h t m l 1939 t t  
 201  
 sept 1940 Ap l 419  
 499  
 compl cr e g  
 1940 A g 1003  
 p l  
 1940 A g 1061  
 l t t ul iug  
 1940 Oct 1357 1371  
 fec 1941 D-c 1640  
 la ph g h py 1940  
 Ap l 475  
 f ll g h y 1940  
 Ap l 440  
 l l t f hld  
 1940 Ap l 377  
 pera h f th t  
 1940 A g 926  
 L p g d l t l 1941  
 J 9  
 l l d m t 1940 Oct  
 1359  
 g l 1940 Oc 1372  
 13 5  
 L ec p 1940 Oc  
 1364  
 L ec phy 1941 t l 147  
 l j 1941  
 Ap l 448  
 L l g pl ca f h ec  
 my 1940 Ap l 439  
 g l l pm t s  
 1941 D-c 1637  
 l 1940 F l 59  
 ml 1941 l 163  
 m 1941 l b 119  
 hock 1940 Ap l  
 431 436  
 L p ec Ueth m

- Ut bl d g b g 1930 F b  
 149 1941 J 865  
 f ct l p l g d  
 1941 O t 1443  
 Ut t b g m 1941 J 9 2  
 Ut body b m l g l b l d  
 g 1941 J 869  
 ca m f 1939 O t 1317  
 1940 Oct 1388 1941 A g  
 1189  
 ll 1940 Ap l 545  
 rv Se C  
 tt m t 1941 F l 81  
 fib m m l b l l g f m  
 1941 J 868  
 f t g l g l sc 1940  
 Ap l 465  
 m l g t l t h py  
 1940 J 871  
 m m 1940 O t 1581  
 p l p se 1940 J 826  
 pe sa y t m t 1941 F b 115  
 g l h y t t m y f 1939  
 J 803  
 t od pl m t p t t  
 t 1941 F b 10  
  
 V D 1383 g l f 1939  
 t p t l p pe t 1940  
 A g 1038  
 V b b l t l p  
 t f 1939 A g 1047  
 t phy g d 1940 F b 109  
 m g y f 1941 F b 81  
 t m t b l t p  
 f 1939 A g 1051  
 V g l b l ed g b l f b g  
 g 1941 J 865  
 h y t t m y 1939 J 803  
 p sa 1941 F l 107  
 m 1941 J 935  
 V soph b l h m h g f m  
 1941 J 726  
 f l 1940 J 703  
 V l 1941 F l 130  
 V 1939 l 15 5  
 p l l l m J 1941  
 Ap l 404  
 V c y th p t sec  
 1939 F l 186  
 V soc d h a c k 1941  
 l d e 1671  
 V p 1940 A g 1099  
 V h t f l l m  
 d k 1941 Ap l 383  
 V t l f b 1941  
 A 995  
 V t l k ph h d J  
 1941 Ap l 315 320  
  
 V t fixat g l g f ia  
 1940 Ap l 465  
 V ca tg t tm t 1941  
 F b 239  
 V t l b h p t  
 r 1939 F b 254 255  
 V t b fifth l mb d pl m t  
 f 1939 Ap l 485 486  
 l mb sa l t t l t  
 ut d t 1939 Ap l 484  
 V t g l t l l 1941  
 Ap l 360  
 f b th 1940 J 72  
 V m t m h p t phy h l  
 l 1940 Ap l 387  
 V l m l d g t l m t  
 1939 Ap l 317  
 V b d m l h t l po thy t  
 t my 1940 Ap l 443  
 V t t l f t l 1939 O t  
 1303  
 V g l f t l 1940 J 813  
 p th t t m 1940 Ap l  
 443  
 V l t m l 1939 Ap l 317  
 g h l 1939 F b 198  
 V t b l f d m g t  
 h d J 1941 Ap l 357  
 V y l th th p l m y  
 m d cat 1940 J 624  
 V l ty p t g sch d l  
 l m g d f t t t 1941  
 Ap l 352  
 d b l ty mp t g  
 t 1941 Ap l 350  
 V ll m p rth pl ty 1941  
 J 895  
 V t m A 1941 J 790  
 V t m B m pl 1941 J 791  
 V t m C 1941 J 791  
 d f y f l f d h J  
 g d d 1940 F b 225  
 g t d d l l t d  
 1940 F b 234  
 V t m K 1941 J 92  
 p d po t pe t se  
 p h m l d f cy 1940  
 A g l 03  
 l p t f h m rth g  
 b l y tra d se se 1939  
 A 891  
 V m l h y t 1941  
 J 789  
 rabl ca er 1940 Ap l 533  
 l c 1940 F b 249 259  
 m l l m d ph logy 1941  
 J 789  
 l ga t l l se se  
 1941 J 789  
 V cal od l 1939 J 819 1940  
 J 05

# 1856 INDEX TO VOLUMES 19 20 AND 21 (1939-1941)

Vocal sed t 1940 A g 912  
 V ikma sch m tra t  
 1940 D-c 1664  
 V l l t t l b t t d  
 t 1941 D 1613  
 f l se tg diagn 1940  
 Oct 1540  
 V m t g ppe d t 1939 Ap 1  
 3 9  
 f p egn cy 1940 F b 252 263  
 V l dyl m t 1941 F b 90  
 m g ry f 1941 F b 81  
 se l h g 1940 F l 109

W 1940 Dec 1788 1811  
 1941 D 1711 1712  
 W A m Medical D pa tm t  
 1941 D-c 1683  
 m-d ympos m 1941  
 D-c 1523  
 l h m h rap 1941 D-c  
 1733 1740 1745 1746 1748  
 f 1941 Dec 1724 1741  
 f ed 1941 D 1730 1739  
 ma g m t 1941 D 1723  
 f hest 1941 Dec 1594  
 f ra se l h rat 1941  
 Dec 1572  
 f 1941 Dec 1563  
 ff ce dy 1941 Dec 1583  
 f h j 1941 D 1623  
 hock f m 1941 D-c 1663

W t or tk t 1911  
 F b 239  
 W t y t ept 1940  
 Ap 1 420  
 b la ma 1940 J  
 883 A g 119  
 m c l m m l 1940 J  
 883

W rk W th m t p t p  
 t 1940 J 826  
 W bbed f g rs 1939 F b 231  
 W est f M B m  
 1939 Ap 1 368  
 W block thesuf 1941 F b  
 283

W h g bscen 1940 Oct 1458  
 W h m bd t m h d fra  
 t f k f f m 1939  
 A g 927  
 t g l m 1939 F b 134  
 loop pe t f eq lg  
 1939 F b 13

W g d M ct m 193 F b  
 258  
 W lm t m 1940 Ap 1 409  
 1941 A g 1176  
 W t lg t t m 1941 J 64  
 W ody phi g 1941 F b 62

W d d acuat f 1941  
 Dec 169  
 tra po t t f 1941 Dec 1 67  
 W d Carr l D k t eatm t  
 1939 Dec 1363 1364 1941  
 D-c 1729  
 l d pl t t tm t 1941  
 D-c 1728 1743  
 t ed 1939 D 1346  
 f 1941 Dec 1724 1 41  
 h l g f 1940 F b 2 9 D  
 1859

sed 1939 Dec 1350  
 f ted 1939 Dec 1365 1368  
 1375 1941 Dec 1730 1739  
 l ted 1939 D 1358  
 ma g m t 1941 D 1723  
 f t m t ea m mm b f  
 t 1941 Ap 1 571  
 f f f 1940 April 573  
 ff 1941 F b 37  
 pe f d pe ru h l  
 d 1941 Ap 1 539  
 p t h f g f m C  
 ( t m d) l 1940 F b  
 225 229 231  
 p t d 1939 D-c 1355 168  
 pa p pl f 1941 Ap 1 5  
 g cal feet 1939 Dec  
 1375  
 ympos m 1939 D 1345  
 t m d g l l g  
 1939 D 1367

f t p t dt  
 m t 1941 D-c 1730 1739  
 hock d h m rth g 1939  
 Dec 1370 1940 A g 1120  
 1941 Dec 15 8 1663  
 t tm t 1939 Dec 134  
 N H d

W t block h u 1941 F b 286  
 d locat 1940 D 1 00  
 f t b 1939 D 1447  
 1940 Dec 169  
 J thl t 1940 Oc 1454  
 pe t f l pa l  
 1939 F b 12

N m f bre 1941 F b 73  
 N od m p b N g d 1940  
 F b 123  
 Ka S R lz

Y p b pe t 1940 Ap 1  
 353

Z per d g g g 1941  
 Dec 1 48  
 g cal feet 1939 Dec  
 1387  
 d 1941 D-c 1734

